GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

Power

A McGRAW-HILL PUBLICATION

APRIL 1956•50¢

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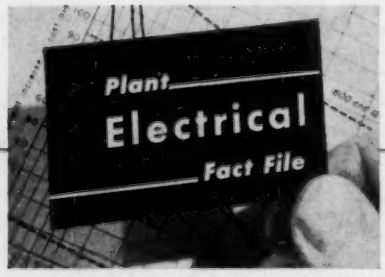
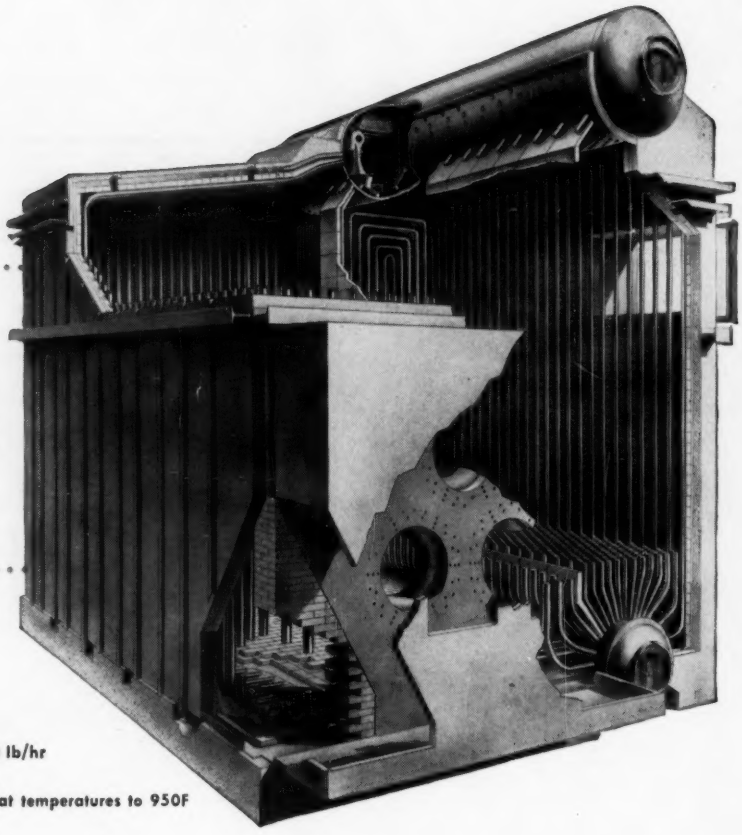


130

Series "SC" STANDARD Steam Generator



FUELS: Oil or Gas
CAPACITIES: 50,000 to 150,000 lb/hr
STEAM PRESSURES: to 1500 psi
STEAM TEMPERATURES: Superheat temperatures to 950F

PRE-ENGINEERED FOR SAVINGS

in first cost, installation, operation, maintenance

Series "SC" Steam Generator is of the pre-engineered, standardized design, with all exterior and structural details fixed. Available in nine sizes, with capacities of 50,000 to 150,000 lbs steam per hr, it incorporates many advanced design features — as noted in the accompanying list — that make possible important savings in industrial steam costs.

Burners, controls, upper drum mountings and other equipment requiring attention are located at the front of the unit. Heat recovery equipment and fans can be placed near the operating aisle for either single or multi-unit installations, providing unusual accessibility and ease of operation.

Write us today for further information on how the Series "SC" Standard Steam Generator can meet your individual plant needs for power or process work. *Foster Wheeler Corporation, 165 Broadway, New York 6, New York.*

FEATURES AT A GLANCE

- Completely water-cooled furnace
- Over 19-foot firing depth
- Unrestricted circulation
- All-welded casing
- Fully drainable superheater
- Efficient convection surface
- Bottom supported unit
- Steam purifying system
- Full insulation

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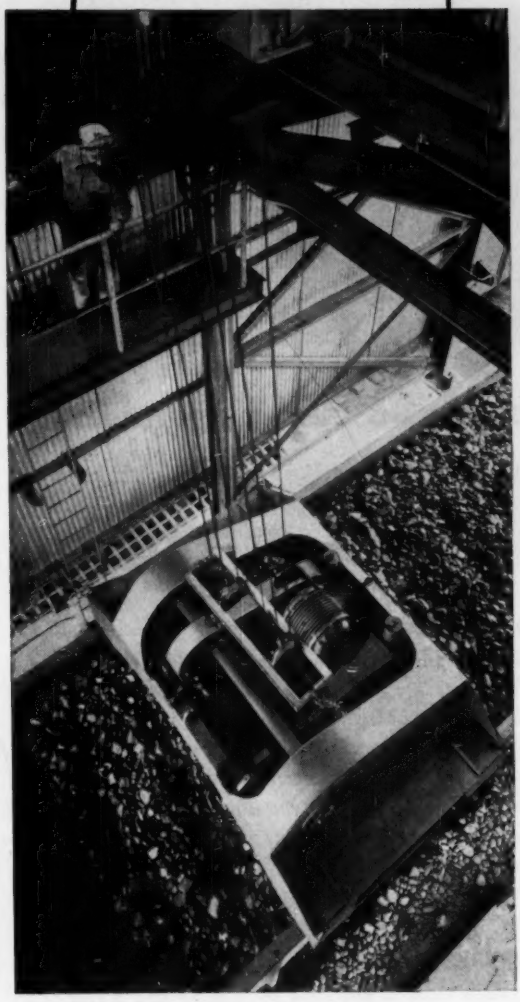
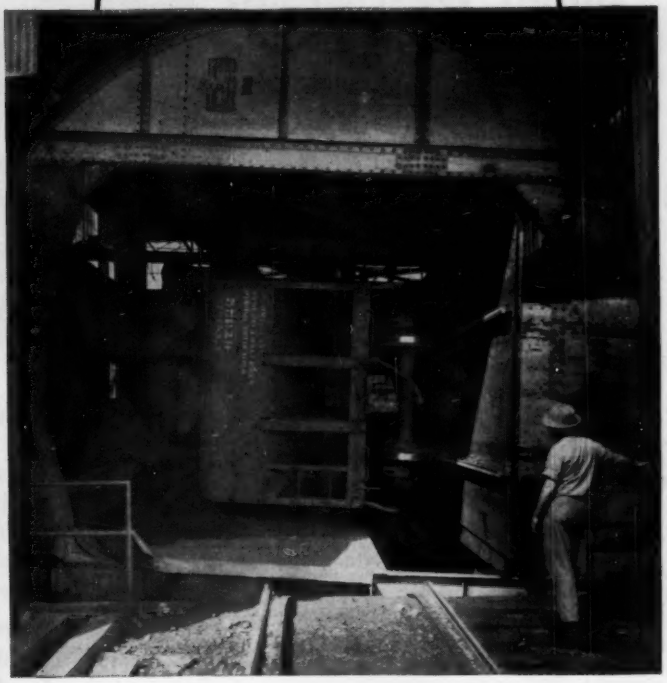
How to appraise your own railroad car unloading needs

CAR SHAKERS for 15 or more cars per day



ROTARY DUMPERS for 15 or more cars per hour



Empty a 90-ton gondola car every 60 seconds or less (including return to upright position) by turning car upside down! Simple, automatic, foolproof. Takes all open-type cars—any length, width or height. Book 2048-A has complete data.

Cut unloading time—free manpower. For example, where a load of wet coal ties up three men for ¾ hours, one man with a Link-Belt Car Shaker can empty the car "broom-clean" in minutes. Exclusive low-frequency vibration minimizes noise . . . is easier on cars. Write for Book 2345.

Only LINK-BELT makes both shakers and dumpers to match all requirements

Choose a railroad car unloading system adequate to meet your needs when operating at full plant capacity. Link-Belt builds the Rotary Dumper for large plants . . . the Car Shaker for smaller operations. Precision engineered, both reduce operational hazards . . . minimize injury possibilities . . . cut costly demurrage charges.

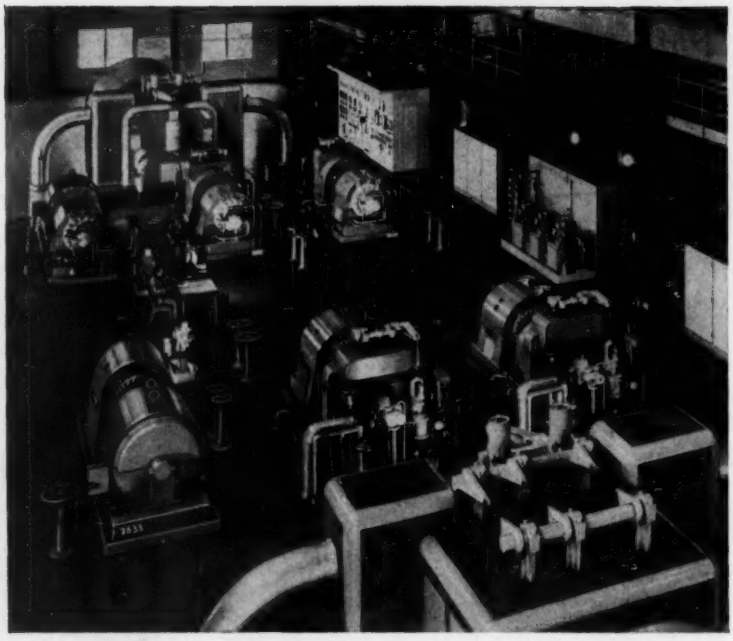
Call your nearest Link-Belt representative. He'll gladly offer further specifics about Link-Belt Car Shakers and Rotary Dumpers . . . make a recommendation based on weight of carloads and character of your materials.

LINK-BELT

CAR SHAKERS and ROTARY DUMPERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.T28

What makes a barrel-type boiler feed pump *stay in service?*



Here are some of the design features that assure dependability

Today's modern multi-stage centrifugal pumps for boiler feed service are the result of years of research and design. To provide efficient service *plus* dependability, De Laval has incorporated these important features in its barrel-type pump.

Double Volute Diaphragms

Double volute diaphragms provide for radial hydraulic balance and assure a continuous rising head characteristic from the design point to shut-off. *RESULT—Higher efficiencies are maintained over a wider range of operation than are generally obtained with other forms of velocity pressure conversion.*

Individual Diaphragm Bolting

Elimination of rabbet fits and gaskets permits straight metal-to-metal contact of adjacent lapped faces of the diaphragms which are individually bolted together to maintain tight joints and ease of assembly. *RESULT—Positive assurance against inner case leakage, complete elimination of misalignment causes and a minimum of distortion from sudden temperature changes.*

Positive Sealing Between Suction and Discharge Chamber

Inner assembly is held at the inner high pressure joint at the suction end of the barrel, against a flexitallic gasket, with through bolts. The joint between the suction and discharge chambers is made tight during assembly—remains tight whether pump is operating or idle. *RESULT—No possibility of leakage or gasket loosening due to changes of force on the inner joint.*

Bare Shaft

Bare shaft construction with split ring-shrink fit method of impeller mounting permits a scalloped shaft design and eliminates the need for spacer sleeves between impellers. *RESULT—Better hydraulic conditions at the eye of the impeller and elimination of spacer sleeves—the greatest cause of shaft warpage.*

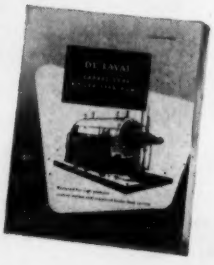
Wearing Rings

Diaphragms and impellers have renewable wearing rings. Impeller rings are threaded on the impeller hubs against rotation, and diaphragm rings are held by a breech lock fit in the diaphragms. *RESULT—Construction permits renewal of original clearances without major part renewal or modification. Labyrinth type diaphragm ring results in minimum leakage over a longer period of time than with close clearance flat rings.*

IMO Oil Pump

A De Laval IMO pump designed for high speed operation is direct-connected to the outboard end of the barrel pump shaft, and is sized to lubricate both pump and driver bearings. *RESULT—Quiet, pulsation-free, positive displacement IMO pumps, assures positive lubrication and eliminates the need of extra shaft length and mechanical complications required by gear drive lube oil pumps.*

BULLETIN CONTAINS HELPFUL DATA



This De Laval bulletin on the barrel-type boiler feed pump covers all major design points . . . has cross-section cut-away illustration for easy reference. Write on your business letterhead for your copy of Bulletin 1506 to De Laval Steam Turbine Company, 815 Nottingham Way, Trenton 2, New Jersey.

Power

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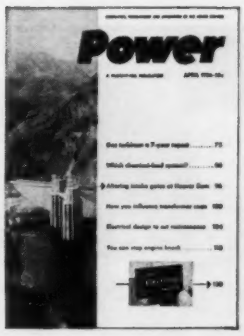

HOOVER DAM intake gates, pictured on the cover, are now revamped for emergency closing. Associate Editor Ben Skrotzki ran across this interesting development last fall, while touring Hoover with Lloyd Hudlow, top operating man. Right there he laid the groundwork for the story on p 96.

Incidentally, Hoover's output was then but 100,000 kw, against installed capacity of 1,200,000, showing effects of a 3-yr drought. Hit also by drought, Southern Nevada Power Co is building a new steam plant—more of that in a later issue.

Next month . . .

Modernization Award in your future? Might be. Check entry details now, p 84; then read in May issue how Garlock Packing Co (a '55 Award plant) racked up big savings through power-service revamp.

Process-type pumps are a cinch to live with once you get squared away on maintenance, inspection. You'll get the main disassembly steps next month.

Electric heat, through mineral-insulated copper-sheathed cable, is filling growing number of local needs throughout plant. This fact-filled article shows you when and how to apply cable heat.

Marmy's 100th story is coming up. It's a dilly of a yarn, spiced as usual with the crusty old lad's homey approach to practical in-plant engineering problems.

. . . and future months

Industrial lighting, a 24-p report in June, will cover today's light sources, fixtures, plant layouts. It's a must for most consultants, plant engineers.

April 1956 POWER Vol 100—No. 4

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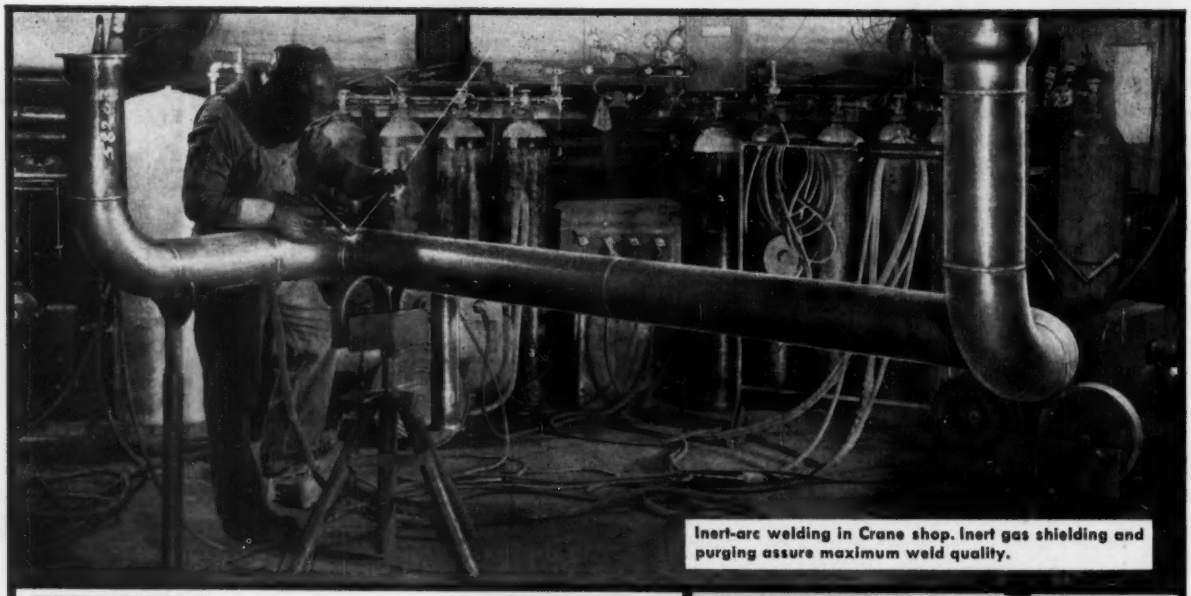
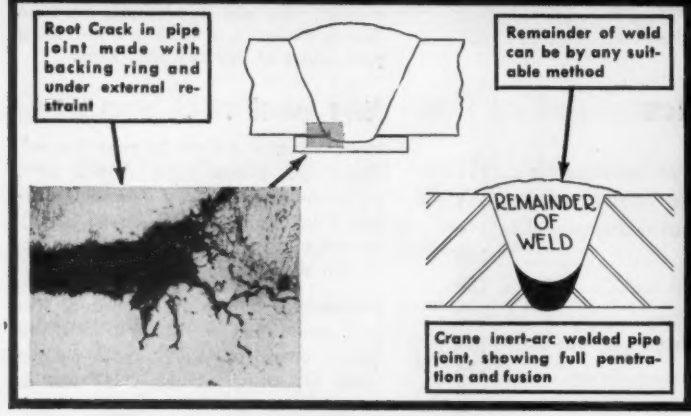
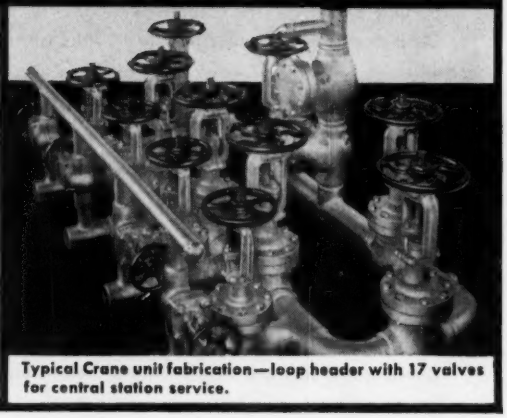


Inert-arc welding in Crane shop. Inert gas shielding and purging assure maximum weld quality.


Root Crack in pipe joint made with backing ring and under external restraint
Remainder of weld can be by any suitable method
REMAINDER OF WELD

Crane inert-arc welded pipe joint, showing full penetration and fusion



Typical Crane unit fabrication—loop header with 17 valves for central station service.

Crane-developed butt-welding technique assures more efficient power piping

Gives important advantages—eliminates backing rings

On shop fabricated assemblies, Crane inert-arc *first pass* welded butt joints are making significant contributions to modern power plant operation.

By eliminating backing rings as used with metal-arc welding, the Crane inert-arc first pass technique assures a high quality weld with smooth root contour without crevices. It eliminates the possibility of basal cracks sometimes associated with backing rings or the characteristics of the base material.

The practicability and dependability of Crane inert-arc *first pass* welding have been thoroughly demonstrated. Leading power plants have been enjoying its advantages for several years, particularly on heavy wall alloy piping for main steam service, and on Schedule 160 carbon steel boiler feed piping.

Welding all types of heavy wall alloy power piping is just one of Crane's services to the power industry. Crane handles every phase of unit fabrication for headers, assemblies and valve groupings—simple or complex, large or small. See your Crane Representative for expert assistance on all power piping needs. Write to address below.

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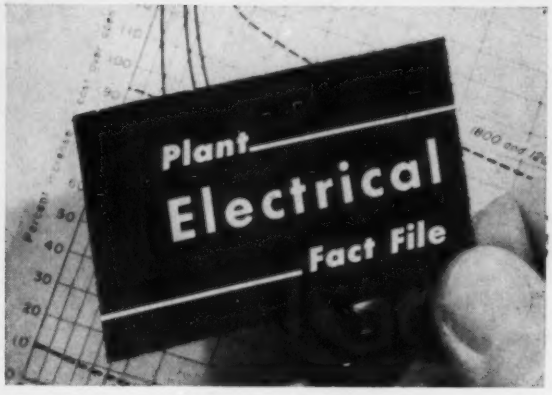
PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

speaking of **Power**

'Plant Electrical Fact File'—your new maintenance helper



More ideas, better ways to tackle electrical maintenance

Today more readers are looking for bigger chunks of practical info on plant electrical maintenance and operation. So starting on page 130, this issue, a new feature bows in: *Plant Electrical Fact File.*

Look upon the *Fact File* as an electrical version of the popular *Operators' Notebook.* The latter, authored by Associate Editor Steve Elonka, has proven gospel for the plant-operating group of POWER readers. Might add that many of the past Notebook articles will soon be available in book form. Title: *Plant Operators' Manual* (1593 drawings and photos!) published in May by McGraw-Hill Book Company.

Like the *Notebook,* success of our *Fact File* will hinge on an editor's ability to ferret out the harder-to-get engineering know-how that readers need for their everyday work. It will be practical and punchy, packed with meaty ideas to help in your job.

New Fact File, not being a primer, will steer clear of straight fundamentals. Rather, it will delve into all the practical electrical areas our plant readers are responsible for. Briefly, it will bring to light better ways used in industry today to handle electrical jobs.

All sides of the general industrial electrical picture will be scrutinized in this new series. Subjects will vary from switchgear to starters, motors to megohms, loads to lighting. Because the central theme will always lie between the primary substation and the final lamp in the plant, *Fact File* will be most helpful to plant engineers and some consultants. The 10 years of practical industrial electrical experience that Assistant Editor Norman Peach brings to POWER will serve well in handling the series.

This business of starting up a new series or department is a matter always on the fire. It must be. We're in a fast-growing part of the engineering business. Technical emphasis in plants and consultants' offices keeps shifting in the constant battle to get a power-service lineup for producing a better mousetrap at lower cost.

We use many barometers to detect early changes in the plant scene. Professional societies, operating groups, plant calls, technical committee work, equipment makers, monthly readers' surveys—they all play a part in helping us spotlight an area that needs attention.

Electrical maintenance forms a prime example. The growth of reader interest in electrical maintenance can be traced in a large measure to zooming electrical responsibilities among the plant-engineer group.

Why more responsibility? Electrical distribution schemes in the modern industrial plant have become the single major power artery finding its way into all plant areas. More and more, secondary energy conversion is being decentralized. Development of compressed air, refrigeration and even steam in many plants takes place closer to the plant's true load center. Because of this continued growth, complexity, reader responsibility, POWER editors kick off *Plant Electrical Fact File.*

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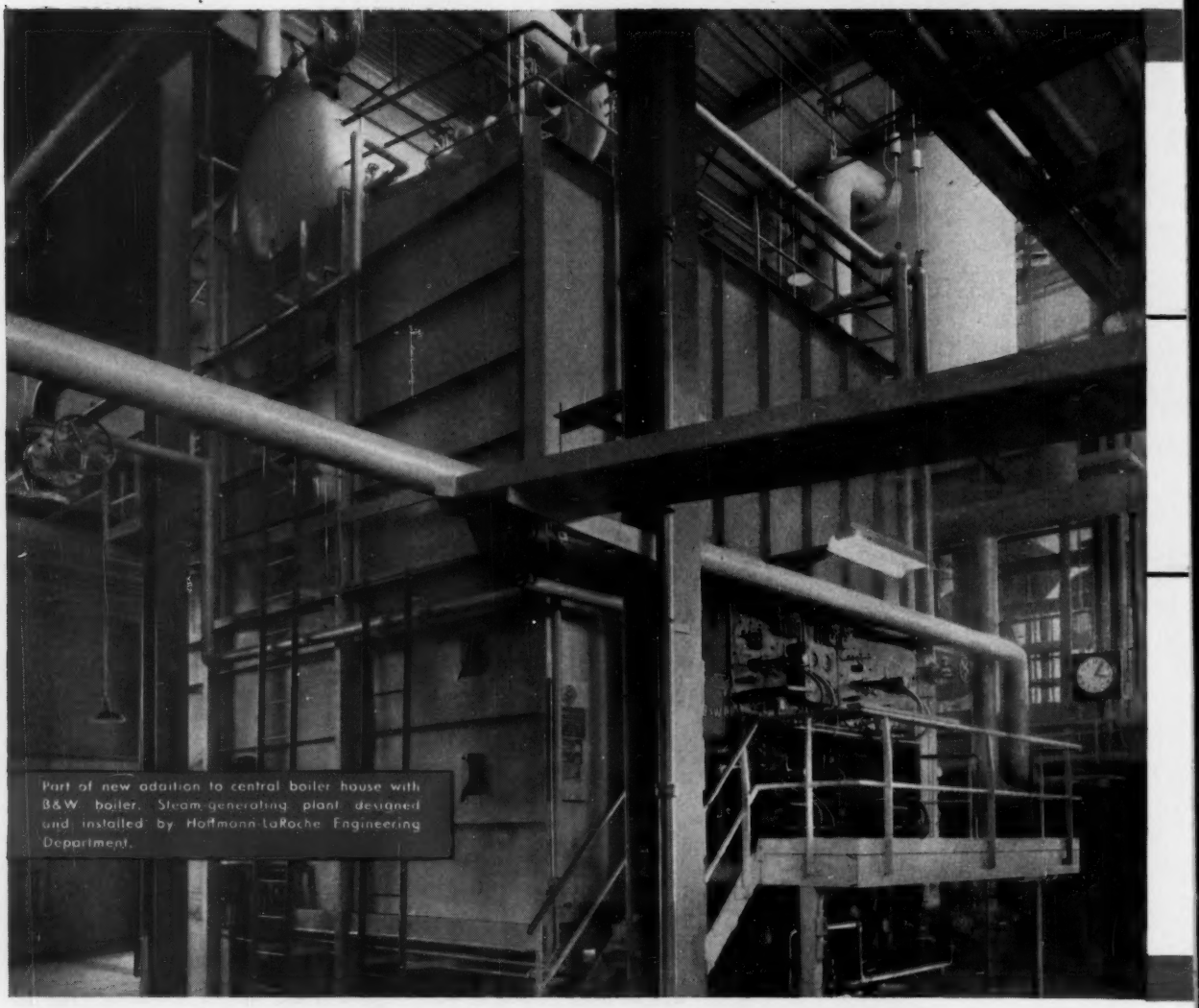


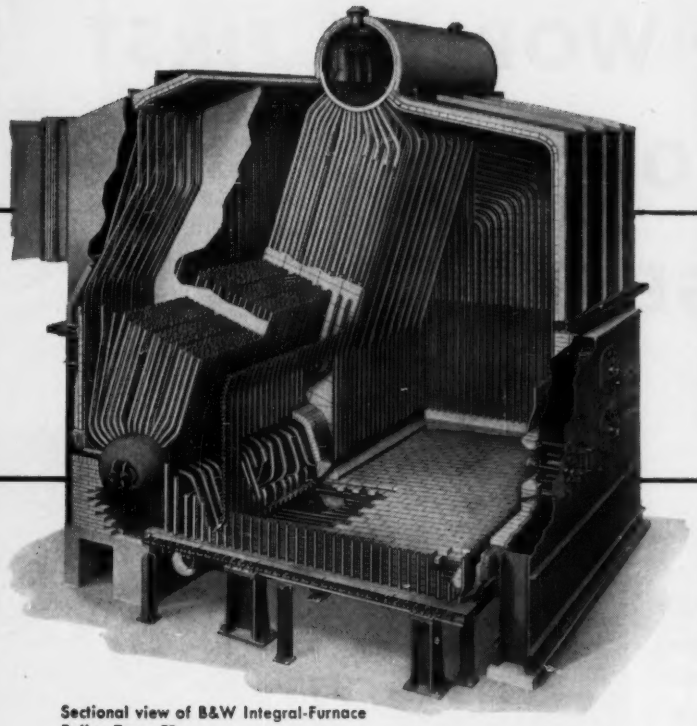
Part of new addition to central boiler house with B&W boiler. Steam-generating plant designed and installed by Hoffmann-LaRoche Engineering Department.

B&W FP BOILER HELPS Hoffmann-La Roche SOLVE SPACE AND STEAM PROBLEMS

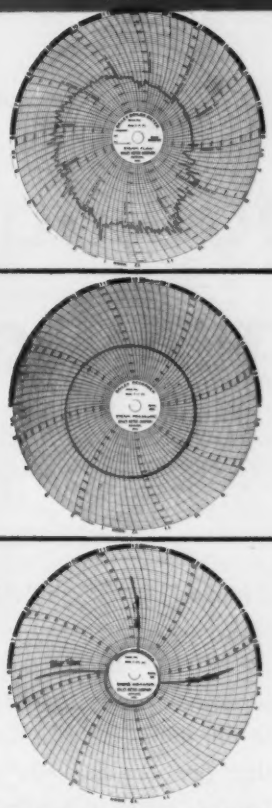
Spotless housekeeping, noticeable throughout Hoffmann-LaRoche's pharmaceutical plant, extends even into the new addition to the central boiler plant at Roche Park in Nutley, New Jersey.

A new B&W Integral-Furnace Boiler replaces four older, smaller and less efficient boilers, now on standby in another boiler room. This centralization of steam generation permits the company to more surely plan the use of that valuable space for expanding production facilities. The new boiler is oil-fired and has a design capacity of 75,000 lb. of steam per hr. The unit has a completely water-cooled furnace that provides durability and eliminates maintenance common to furnaces having considerable exposed refractory.

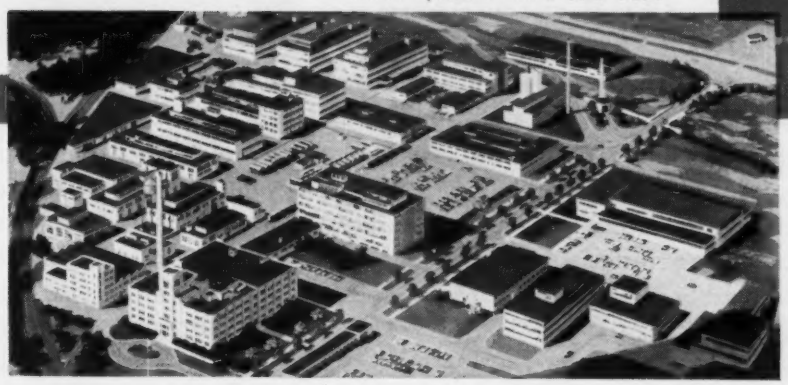
Choice of this B&W Integral-Furnace Boiler, as part of Hoffmann-LaRoche's continuing modernization program, was the result of careful weighing of all factors involved in the heating and processing operations. The program required additional dependable steam on tap in sufficient quantities at all times. Then, too, wide load swings have to be handled smoothly and economically. The B&W Boiler does this under complete auto-



Sectional view of B&W Integral-Furnace Boiler Type FP.



Steam flow, pressure, and smoke charts indicate handling of variable loads at constant pressure with a clean stack.



ROCHE

matic control, providing peak efficiency over the load range. An indication of the quick response and flexibility of the boiler in handling the load swings is indicated by the charts.

Like so many other companies of all kinds, where steam is required—for processing, heating, hot water, air conditioning—Hoffmann-LaRoche has selected an efficient B&W Boiler that precisely meets its needs for reliable, economical steam, and is backed by a policy of reputable service that assures complete satisfaction. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

BABCOCK & WILCOX

B&W

BOILER DIVISION

G-770

DIAMOND BLOWERS

Selected for WORLD'S FIRST 2,000,000 POUND STEAM GENERATOR

UNIT No. 3

RIVER ROUGE POWER PLANT

The DETROIT EDISON COMPANY

When Unit No. 3 at the River Rouge Power Plant of The Detroit Edison Company goes into operation late in 1957, its 2,000,000 pounds-of-steam-per-hour Foster Wheeler steam generator will make it the largest in use. The design pressure is 2700 psi and the superheater outlet pressure is 2450 psi. Superheater outlet temperature is 1050 F and the reheater outlet temperature is 1000 F.

As indicated by the drawing at the right, Unit No. 3 is in effect two units operating side by side as one. Both furnaces are identical, each containing a radiant superheater in the front and side walls. All convection superheater surface is located in one and all reheater surface in the other.

Unit No. 3 will be cleaned by Diamond Blowers . . . new type Model IK long retracting blowers for the tube banks and Model IR short retracting blowers for the walls. The cleaning medium is compressed air and the electric motor driven blowers are automatically and sequentially controlled by a Diamond Selectromatic Panel.

This is another of the many outstanding installations for which Diamond Blowers have been selected.

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

Diamond Specialty Limited • Windsor, Ontario

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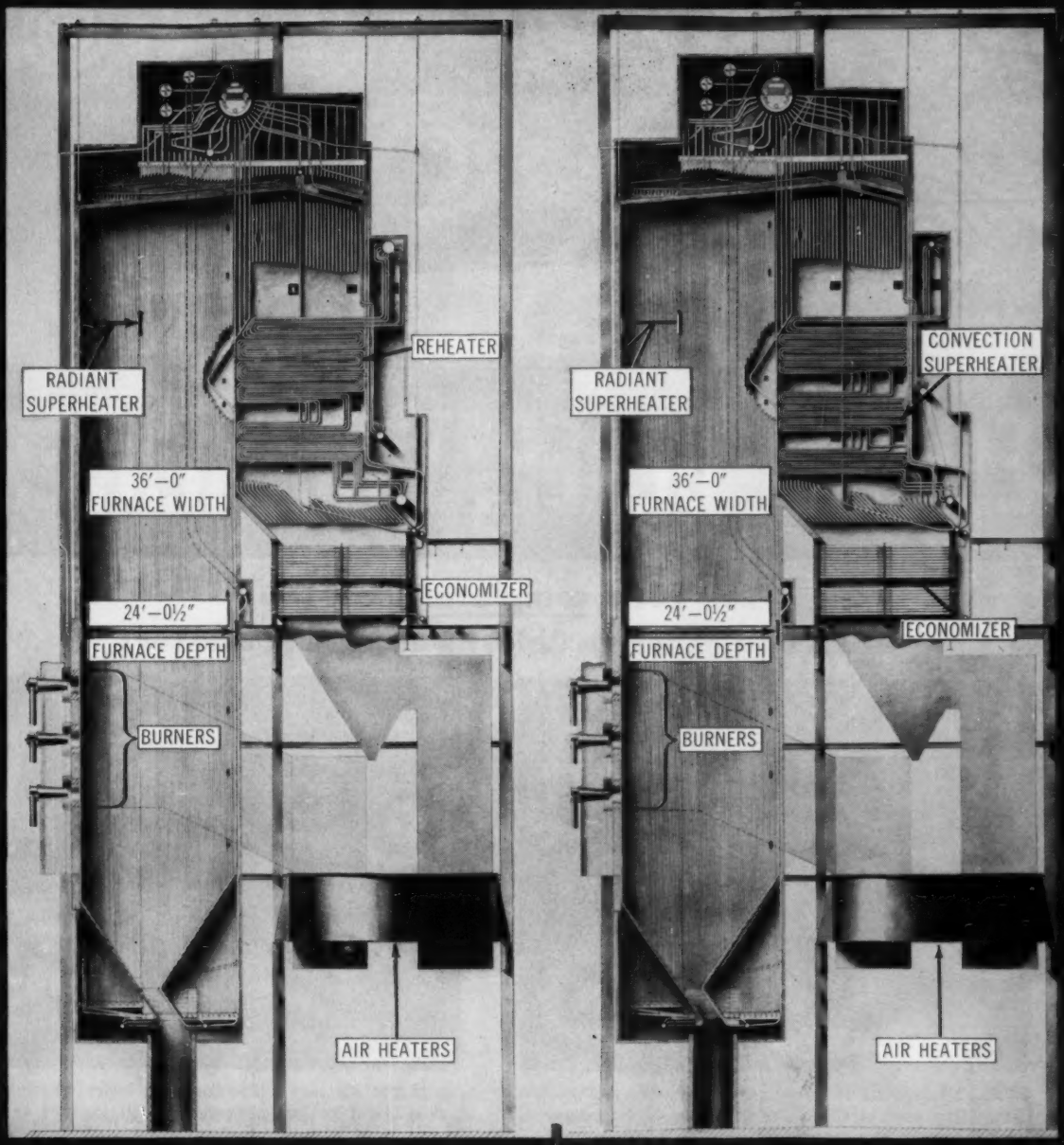
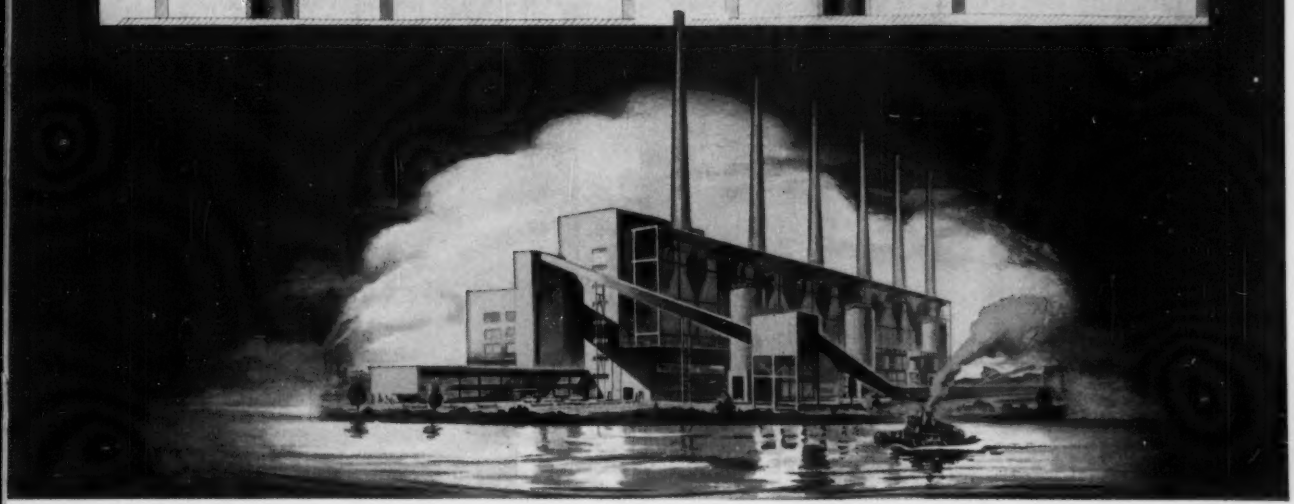
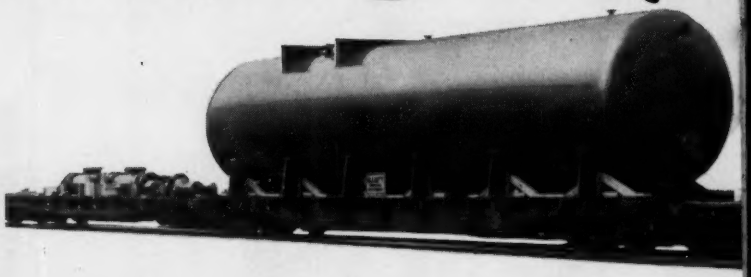

RADIANT SUPERHEATER
REHEATER
36′—0″ FURNACE WIDTH
ECONOMIZER
24′—0½″ FURNACE DEPTH
BURNERS
AIR HEATERS
RADIANT SUPERHEATER
CONVECTION SUPERHEATER
36′—0″ FURNACE WIDTH
24′—0½″ FURNACE DEPTH
ECONOMIZER
BURNERS
AIR HEATERS



We don't kiss them goodbye



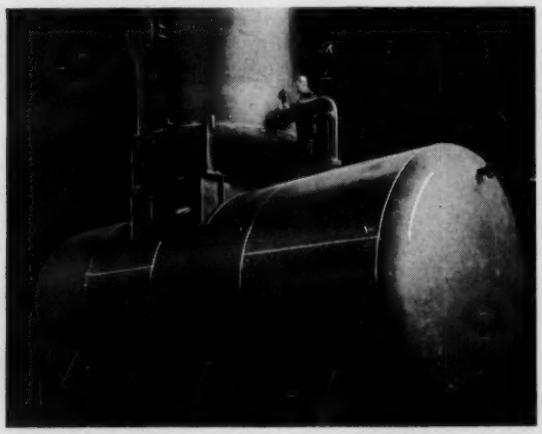
ELLIOTT DEAERATING HEATERS

You get a complete Elliott job when you order an Elliott Deaerating Heater!

Elliott staff engineers do the design work, operating in a tradition set by forty years of Elliott deaeration progress and experience.

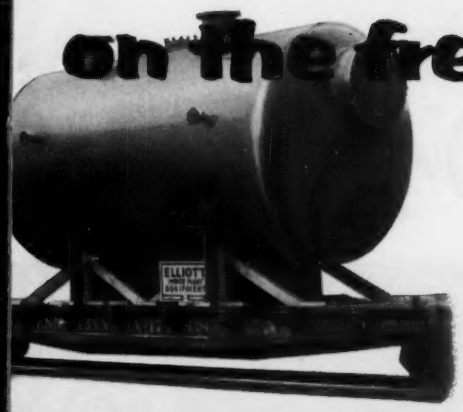
Construction starts on a large deaerating heater. All construction work is done in the large, well-equipped Elliott, Jeannette, Pa. plant.

The Elliott welding shop where the "big ones" are built. Construction is in accordance with rigid ASME code requirements.

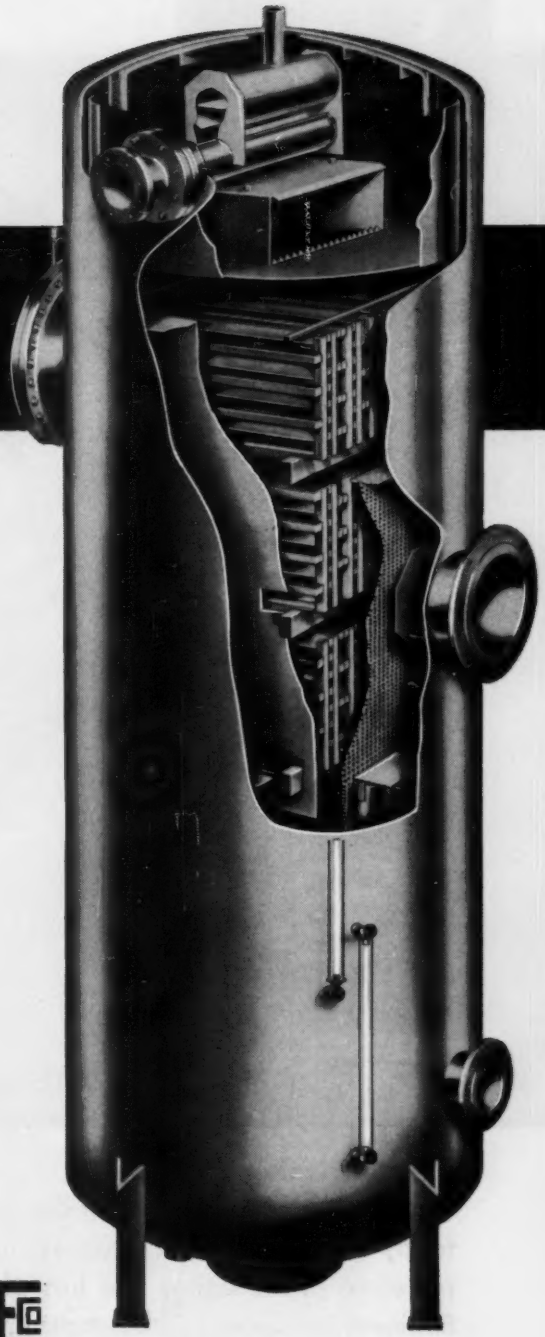


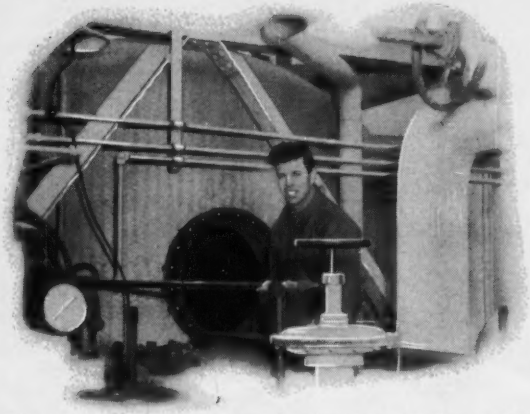
Elliott maintains complete facilities for hydrostatic testing. Every Elliott deaerating heater receives an "ok" here prior to shipment.

on the freight siding!



. . . are backed by field service attention throughout installation, start-up and operating life.

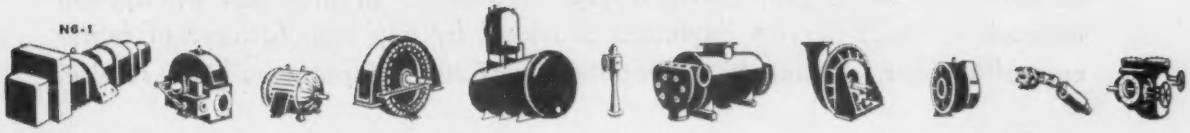




Elliott engineer inspects deaerating heater installation during periodic plant shutdown.

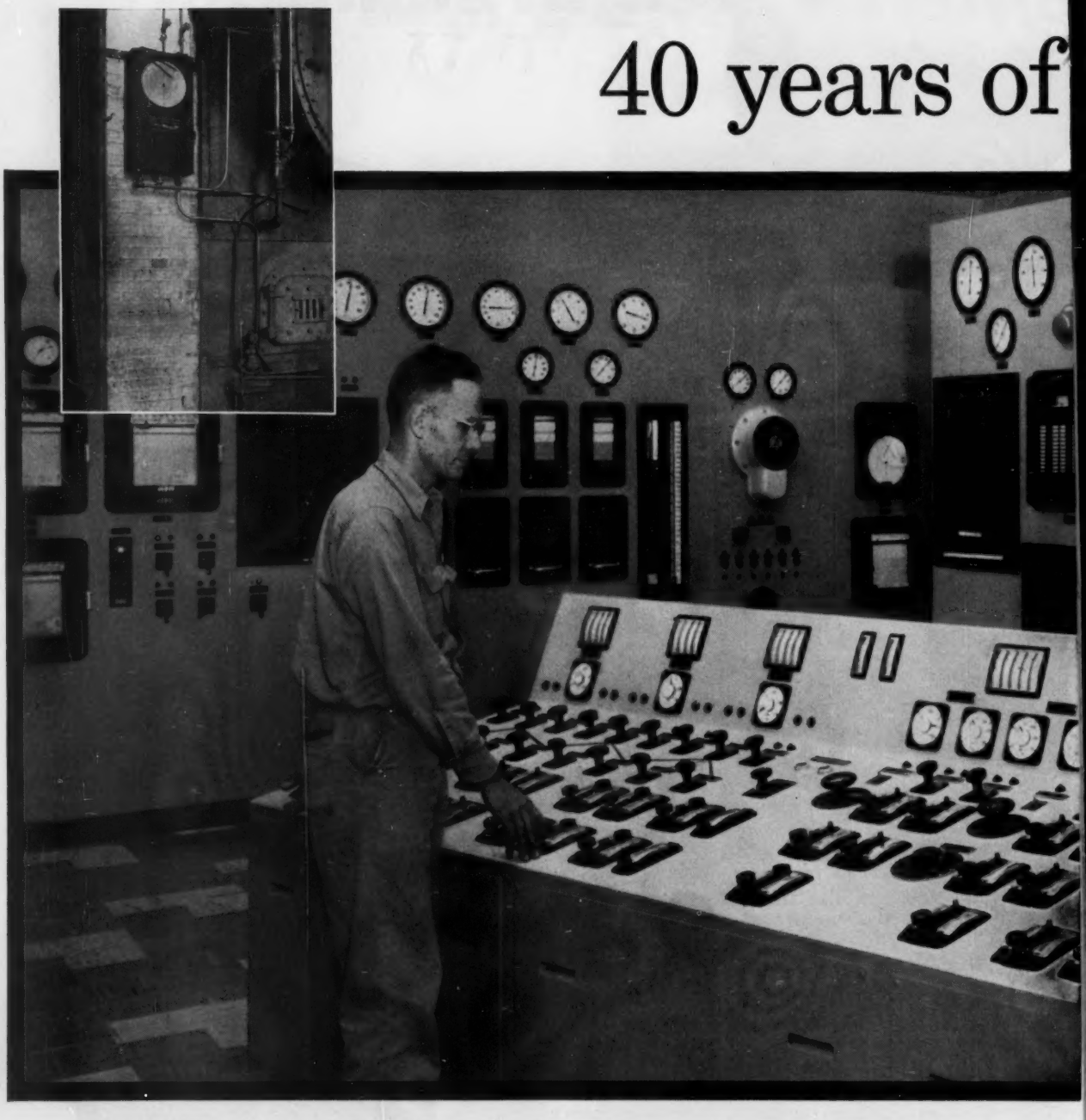
Elliott deaerating heaters are not only designed and fabricated in the Elliott Company headquarters plant, but are backed by Elliott factory-trained field engineers who are available for consultation on pre-installation questions, and for help on start-up and maintenance throughout the life of the equipment. For complete information on Elliott deaerating heaters, write Elliott Company, Jeannette, Pa.

ELLIOTT Company



TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

40 years of



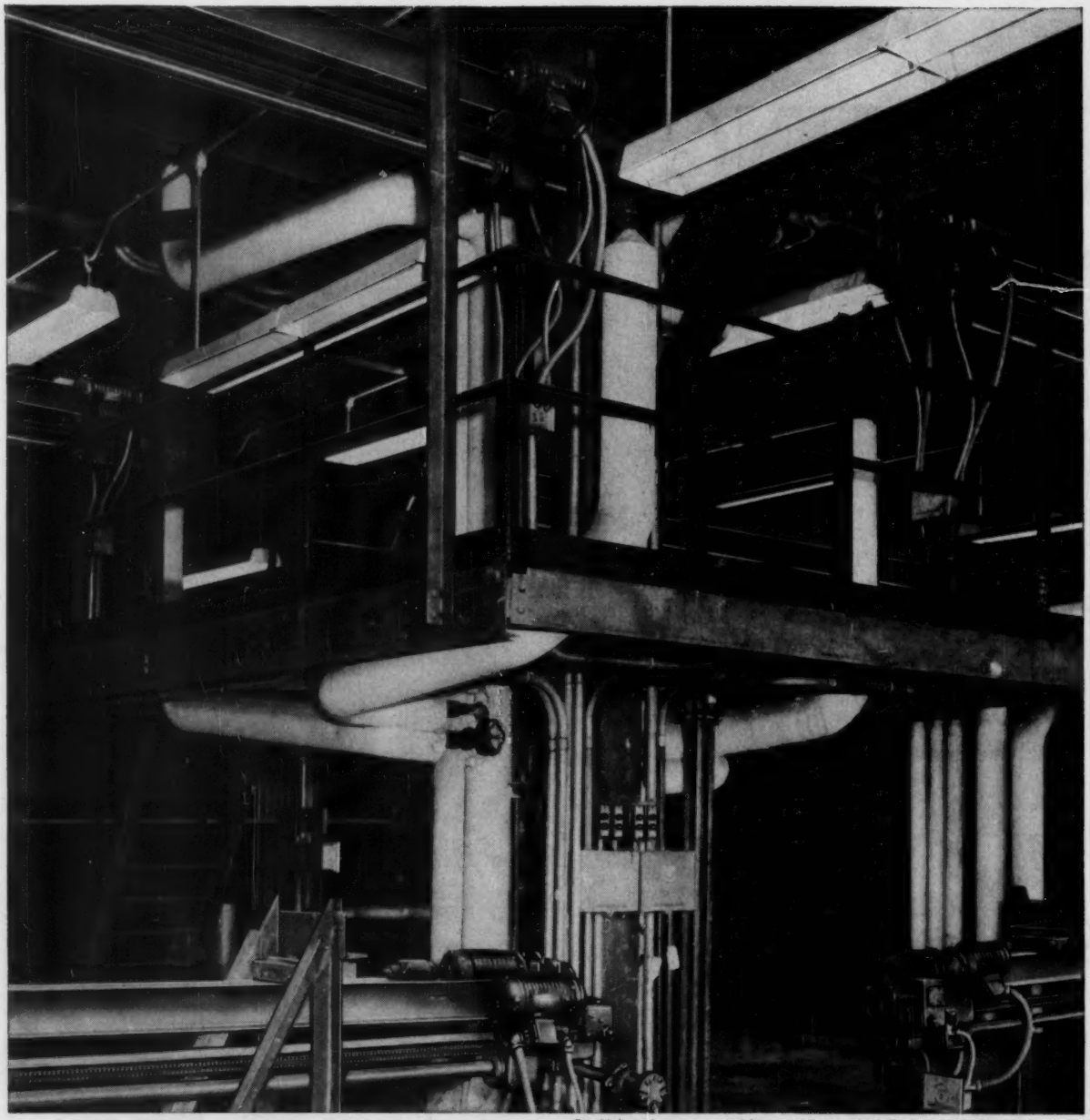
As ASME celebrates its 75th, Bailey Meter Co. completes its 40th year . . . The contrast between the Bailey installation of 1916 and the control room of today shows 40 years' progress in boiler control. In this progress, the completeness of the Bailey line has played its part, as has the breadth of Bailey Engineering Service . . . but most important has been a steadfast service policy of *making it work. That policy is expressed today in the most widespread network of Sales-Service Engineers provided by any manufacturer of boiler control systems,* sustaining the reputation of *the company built on service.*

"MAKING IT WORK"...

BAILEY
METER COMPANY
1036 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS

A127-2



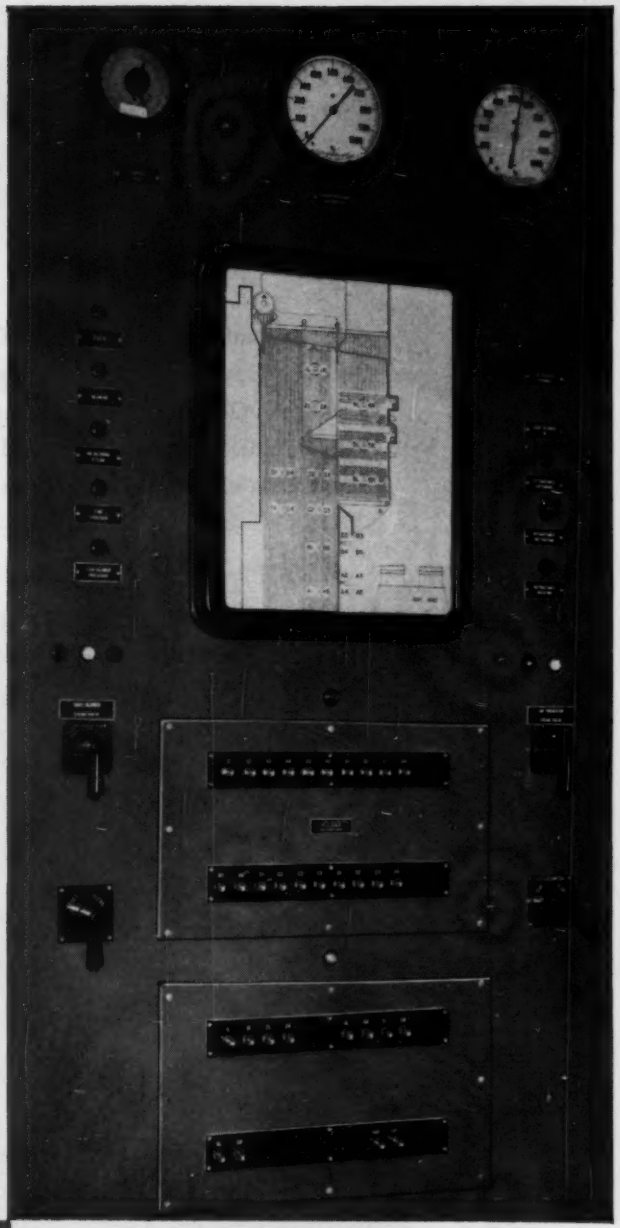
Six Vulcan long retractable soot blowers installed on Units 1 and 2. Vulcan long retracts have been built for travels over 35 feet. They can blow with steam or air without change in equipment.

Georgia Power Company installs VULCAN automatic-sequential soot blowing system

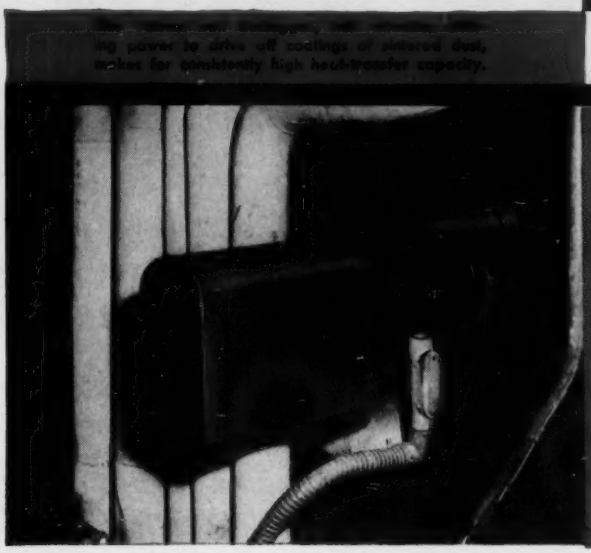
Keeping three Babcock & Wilcox reheat boilers effectively clean is a push-button operation at Georgia Power Company's Plant Hammond. That's because each boiler is equipped with Vulcan Automatic-Sequential Soot Blowing. The system includes both long retractable soot blowers and wall deslaggers.

The centralized control panel for each electrically-driven system is located in the main boiler control room. There the operator starts the cleaning sequence by simply pushing a button. He can see at a glance that each unit starts operation at the right time and pressure, blows for the proper period, and cuts out of service. If an individual blower requires more frequent or prolonged operation, manual control is right at his fingertips. With Vulcan, each boiler section is cleaned efficiently, automatically. No soot or slag accumulates to decrease operating efficiency.

No matter what size your boiler—whether it's power or process—you can increase operating efficiency and get low cost, effective cleaning with Vulcan Automatic-Sequential or Selective-Sequential Soot Blowing.



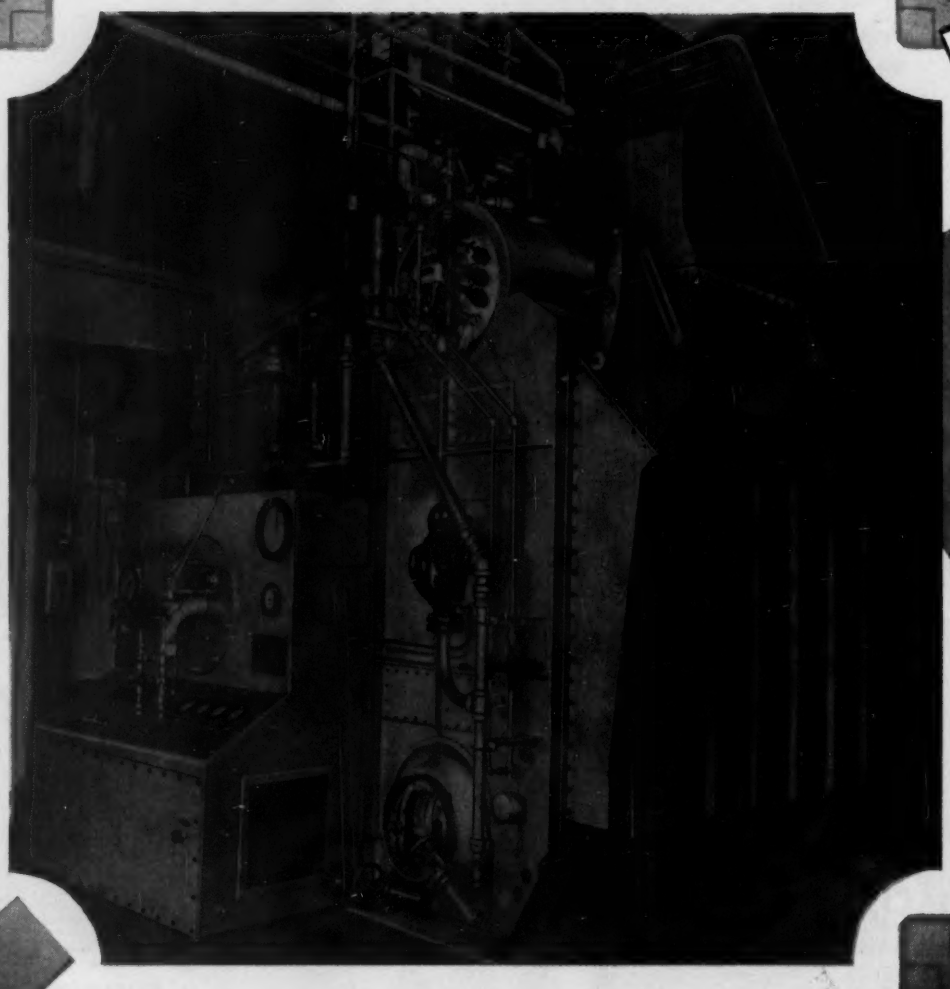
From this central control panel, the operator can check each step of the cleaning cycle; has choice of automatic or manual control.



"You can't get a Better

Says Stanley D. Loomis, Chief Engineer of The United Piece Dye Works, a leader in the field of textile dyeing, finishing and printing. Of course, he's referring to the C-E Package Boiler, Type VP – installed in the newest and most modern United Piece Dye Mill at Charleston, South Carolina.

let's look at the box score for 1955 —



Boiler Box Score"

SCORE CARD

AT BAT — 3 shifts a day, 6 days a week without a single unscheduled outage.

RUNS — around the clock with a quick response to load change and an ability to sustain a high overload capacity while producing high quality steam.

HITS — the performance mark. C-E's prompt service and complete cooperation matches the quality of the boiler.

PUT OUTS — of maintenance and repair bills are assured by the boiler's conservative design and built-in advantages. To date there have been no repair bills at all.

ASSISTS — in the continued full-production operation of the plant by meeting every steam need unfailingly.

Need a Package Boiler? See C-E! You can't get a better boiler box score.

COMBUSTION ENGINEERING

B-911

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

STEAM GENERATING UNITS • NUCLEAR REACTORS • PAPER MILL EQUIPMENT • PULVERIZERS
FLASH DRYING SYSTEMS • PRESSURE VESSELS
HOME HEATING AND COOLING UNITS • DOMESTIC WATER HEATERS • SOIL PIPE

"this is

● Engineers tell us Yarway Remote Liquid Level Indicators are the most dependable boiler insurance they can have.

Instant . . . accurate . . . brilliant . . . continuous readings of boiler water level are seen on the panel or wherever you wish in your plant. You know the readings are right because they are controlled by the boiler water itself . . . by the pressure differential between a constant head of water and the varying head in the boiler drum. *Indicating mechanism is never under pressure.*

Yarway Indicators may be equipped with a Yarway Control Unit that operates Remote Hi-Lo-Alarm signal lights or horns. For a 24-hour record of boiler water levels, use the Yarway Hi-Lo-Graph Recorder.

On the boiler drum itself you'll want Yarway Water Gages . . . and these "bright as a star" gage readings can now be televised with a Yarway—RCA Television chain.

From drum to panel and at all remote locations, Yarway equipment gives you the safest boiler protection you can buy . . . proved beyond doubt in thousands of power plants.

Write for the specific bulletins you want.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

WIDE VISION!

Clear, brilliant readings from any angle, are possible with the "wide vision" face on the Yarway Remote Liquid Level Indicator. Pointer is always visible, even at extreme high and low water levels.

The Yarway Indicator is manometric type with automatic temperature compensation, as approved for use under the ruling of A.S.M.E. Boiler Code Committee in Case # 1155.

Described in Yarway Bulletin WG-1824.

YARWAY

good boiler insurance!"

YARWAY WATER GAGES

Flat glass, high pressure type shown, features new separated-design insert and Type "M" illumination that causes water level meniscus to "shine like a star". Described in Yarway Bulletin WG-1812.

YARWAY REMOTE SIGNAL ALARMS

Lights on horns, operated by Control Unit on Yarway Indicator, give instant warning of any serious deviation from normal water level. Can be located anywhere in plant. Described in Yarway Bulletin WG-1824.

YARWAY HI-LO-GRAPH RECORDER

Gives a continuous 24-hour record of liquid levels. Actuating mechanism is same as in Yarway Indicator. Used both for indicating and recording. Described in Yarway Bulletin WG-1830.

YARWAY TELEVISION

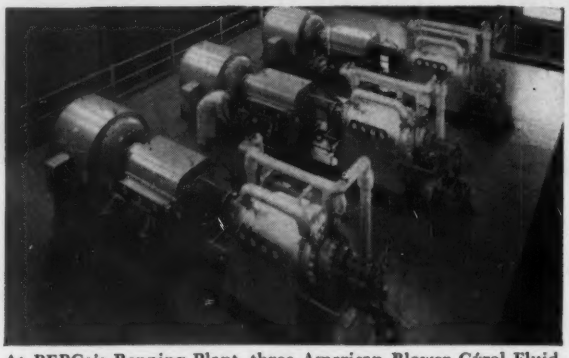
Simplified system consists of compact camera and panel-mounted monitor. Clear, bright image of water level gage anywhere in the plant. Described in Yarway Bulletin WG-1813.

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
LIQUID LEVEL INDICATORS
EXPANSION JOINTS
STEAM TRAPS
STRAINERS
SPRAY NOZZLES
DIGESTER VALVES

Potomac Electric Power

The Potomac River Plant is one of three PEPCo electric-power giants serving Washington, D.C., and nearby areas of Maryland and Virginia.



At PEPCo's Benning Plant, three American Blower Gyrol Fluid Drives provide adjustable-speed control for boiler-feed pumps. Each is rated at 1250 hp at 3600 rpm. Six Gyrol Fluid Drives for the same application are installed at the Potomac River Plant — each is rated at 1750 hp at 3600 rpm.

American Blower Forced Draft Fans are also installed at the Potomac River Station. Fans on Boilers 1 and 2 are rated at 113,000 cfm @ 100°F @ 11.0" sp @ 1150 rpm. Fans on Boilers 3 and 4 are rated at 111,000 cfm @ 100°F @ 17.5" sp @ 700 rpm.

records all-time peak load:

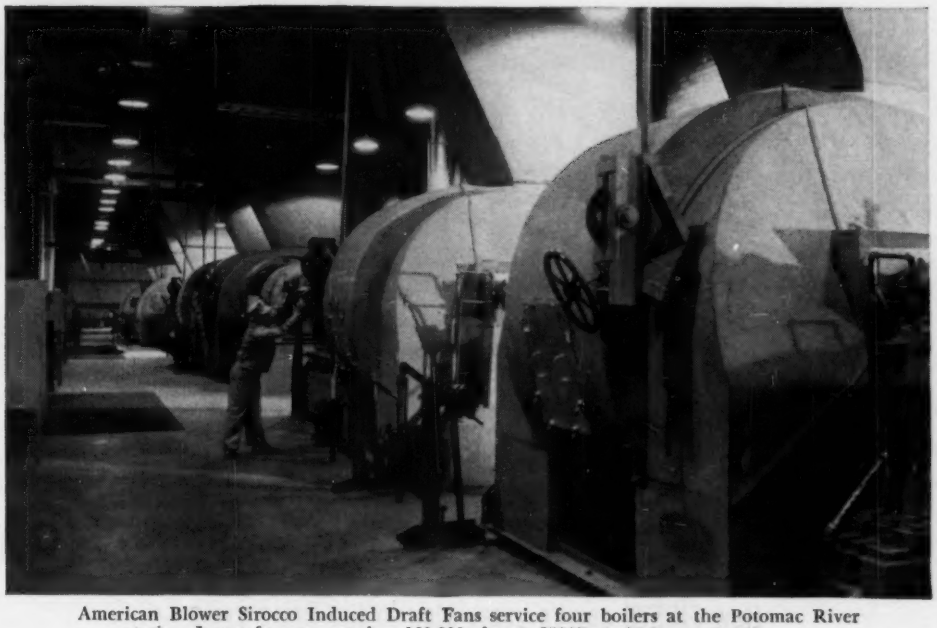
810,000 kw

Potomac Electric Power Company's new high peak load of 810,000 kw in 1955 marked a 9.3% increase above the peak of the previous year. Although it was appreciable, the boost is only the beginning.

The coming years will see the continuation of an expansion program in which Potomac Electric Power Company has been engaged since the close of World War II . . . to better serve its more than 320,000 customers in the District of Columbia, and areas of Maryland and Virginia. During the 14-year period, 1947 to 1960, additions to PEPCo's electric plant are expected to total $320 million.

As an important part of its power build-up, PEPCo relies on American Blower Mechanical Draft Fans for efficient air handling and Gyrol Fluid Drives for smooth power transmission.

Like PEPCo, many other progressive utilities depend on American Blower equipment to meet rigid power-plant demands. Perhaps we can serve *you*, too. Call our nearby branch office for full data on our Mechanical Draft Equipment, Fly Ash Precipitators, Heavy Duty Steam Coils, and Gyrol Fluid Drives for boiler-feed pump and fan control.



American Blower Sirocco Induced Draft Fans service four boilers at the Potomac River station. Latest fans are rated at 160,000 cfm @ 250°F @ 18.0" sp. @ 667 rpm.

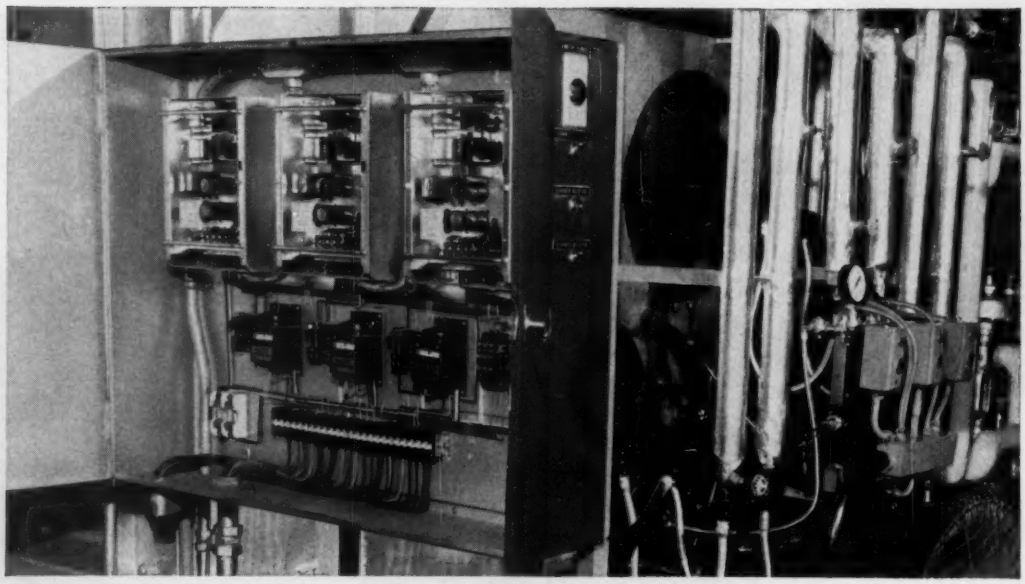
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN • CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American-Standard

AMERICAN 75th ANNIVERSARY YEAR **BLOWER**

a fireye Interlock System went in AFTER THE EXPLOSION...

Back Up Your Boiler Operator with Safeguards that



How FIREYE covers every step in the firing cycle —

PREVENTS hurrying or skipping steps essential to safe operation
PREVENTS light-off until combustion chamber and passages are purged clean
BLOCKS main fuel supply until pilot is proved at the right point for light-off
SHUTS OFF fuel if main flame does not stabilize within the trial-for-ignition period
SHUTS OFF fuel and sounds alarm if the flame goes out during the firing period

THE RESULT OF 1 SLIP

IN 15 YEARS OF PERFECT PROCEDURE

Cost of new boiler — $35,000 . . .
Cost of lost production — much more

FOR 15 YEARS a well-designed boiler and an experienced and thoroughly competent operator were enough for safety in this large New England plant. Of course, there was a "standard" type of burner safeguard present as well.

THEN, came one of the slips that prove no human is infallible. The operator attempted to light off a second burner from one already firing. The "safeguard" was too slow . . . there was a flash . . . the boiler was destroyed . . . production was shut down for months.

Protect Every Stage of Light-Off and Firing

Your boiler operator knows how great the need is for an assistant like Fireye. He knows that incorrect light-off or flame failure can occur in even the most modern burner installations. He knows that operators are only human, that they can slip. He is keenly aware that in an emergency no man can always act fast enough to avert disaster.

Fireye is the proved, complete, factory-integrated system that foresees and forestalls hazards of fuel burning in multiple-burner installations. With its Firetron "eye" that constantly monitors all stages of the firing cycle, Fireye acts within 2 to 4 seconds of the start of trouble. Its system of timers, interlocks, and shutoff valves automatically supervises every operating step.

The Fireye organization brings to your problems a knowledge and experience in fuel burning control that is without equal. It benefits you whenever Fireye engineers, located throughout the country, come in to survey your situation . . . supervise installation of Fireye equipment . . . check out the installation, and train your operating personnel.

Fireye alone can serve you so completely — and your need for its services may be greater than you realize. Begin TODAY, by mailing the coupon for your copy of a non-technical bulletin that explains why most fuel-burner explosions happen, and how Fireye prevents them.

E C A fireye

Other ECA Divisions: Photoswitch Division • Fireye Division • Marine Division • Business Machines Division • Photoconductor-Transistor Division • Military Division

Protect Your Boiler NOW — send for this

COMBUSTION CONTROL DIVISION • ELECTRONICS CORPORATION OF AMERICA
Dept. C9-4, 718 Beacon Street, Boston, Mass.
In Canada, write Electronics Corporation of America (Canada) Limited, Box 111, 98 Advance Road, Toronto 18.

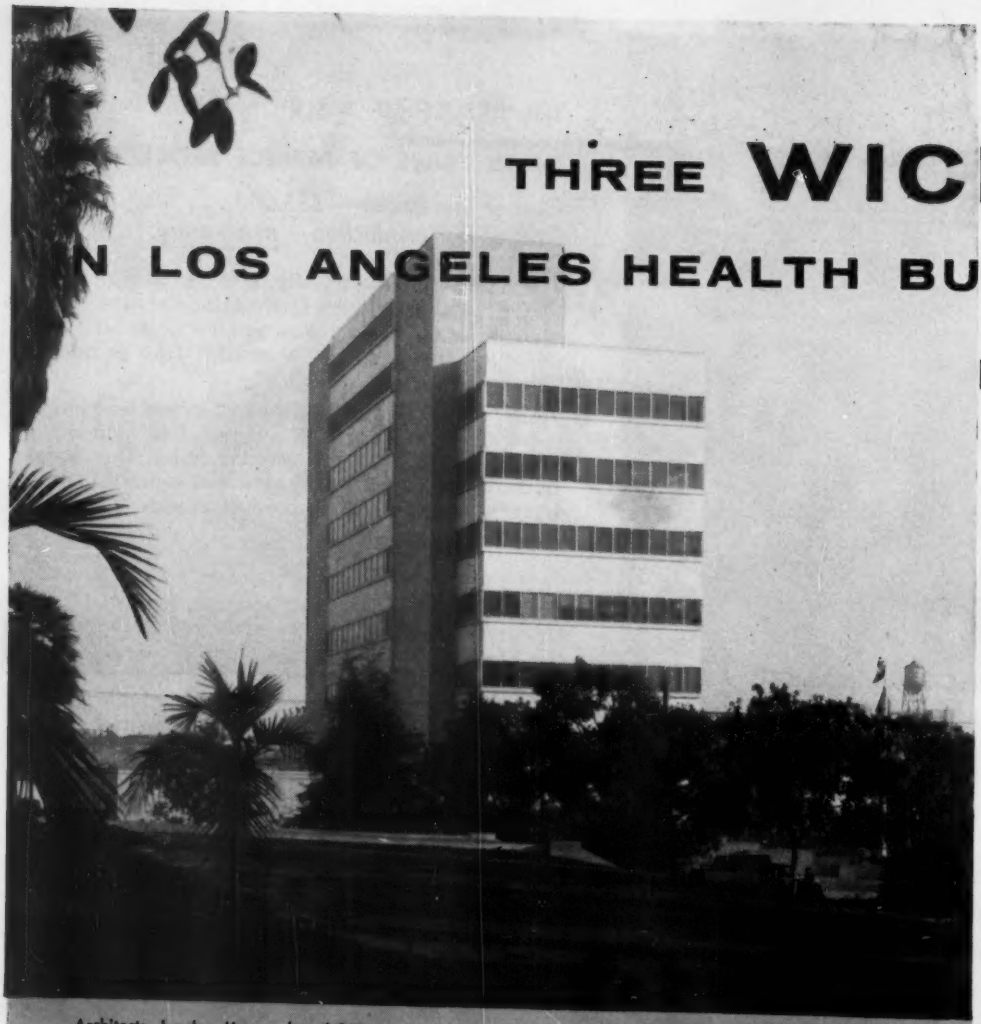
Send Bulletin CP21 on Flame Failure Explosions

NAME _____

FIRM _____

ADDRESS _____

THREE WICKES IN LOS ANGELES HEALTH BUILDING IS THE WICKES

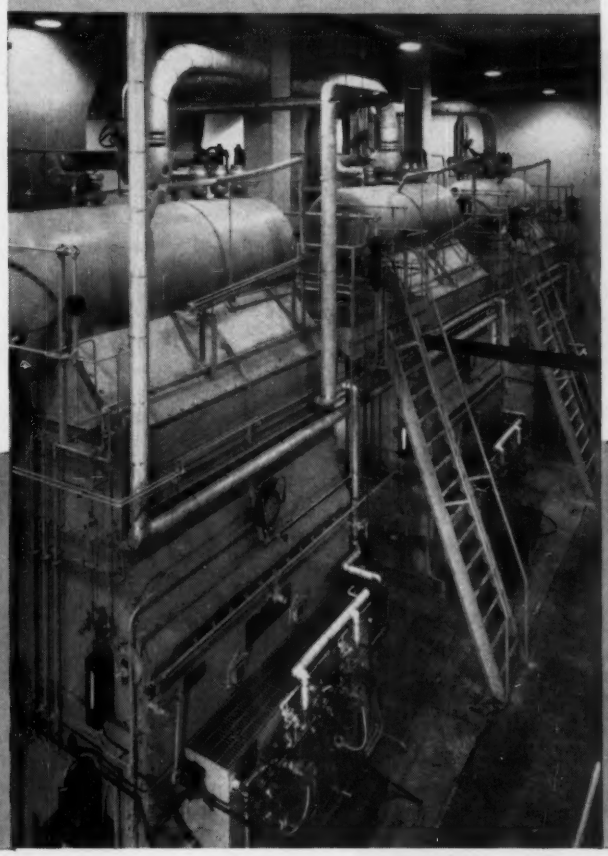


Architects: Lunden, Hayward, and O'Connor
Builder: Robert E. McKee General Contractor, Inc.

Housed in the striking modern structure shown here is a new clinic and health center for the city of Los Angeles Health Department. Beautifully equipped in every respect, the building has individual room thermostats to insure the exact desired temperature in each separate area . . . clinics, laboratories, medical sections, and others. To insure that the heating system responds immediately to these controls, the builders installed three dependable Wickes water tube steam generators. In addition to supplying the big nine-story Health Center with heat, the Wickes boilers also serve the entire City Hall building nearby, and the new Police Facilities building (a feature of this integrated Civic Center layout is that these buildings are connected to the Health Center by pedestrian tunnels, which are likewise heated by the Wickes boiler installation). Pictured at right is one of the modern health laboratories.

STEAM GENERATORS WHERE DEPENDABILITY MOST VITAL FACTOR

The three Wickes boilers shown below supply heat for not only the Health Center but also the City Hall and new Police building.

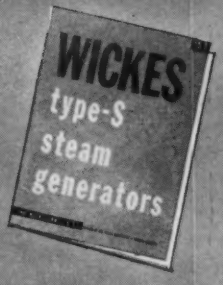


These 2-drum type-S Wickes steam generators are compact and efficient water tube units. Built to a design pressure of 160 psi, and with 3400 square feet of heating surface, each of these Wickes units is fired by 2 Multijet Combination gas and oil burners. They are quickly responsive to extreme fluctuations in load, and the large steam drums make certain of ample steaming capacity with dry steam. Wickes 2-drum type-S steam generators are readily adaptable to completely automatic control.

Other Wickes 2-drum, type-S, shop-assembled steam generators are available in the Series S1A and S2A. These units combine the water cooled furnace as an integral part of the boiler, adapting the high and low type furnace to the desired method of firing . . . coal, oil or gas. They are built to the design pressure of 725 psi; superheaters and recovery equipment are available.

WRITE FOR OUR NEW BROCHURE

Our new Catalog 55-2 contains complete information on Wickes 2-drum type-S steam generators. A general description is given of these shop assembled boilers, together with four insert pages of engineering drawings and data. We will also send you our complete facilities Bulletin No. 55-1.



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THE WICKES BOILER CO.

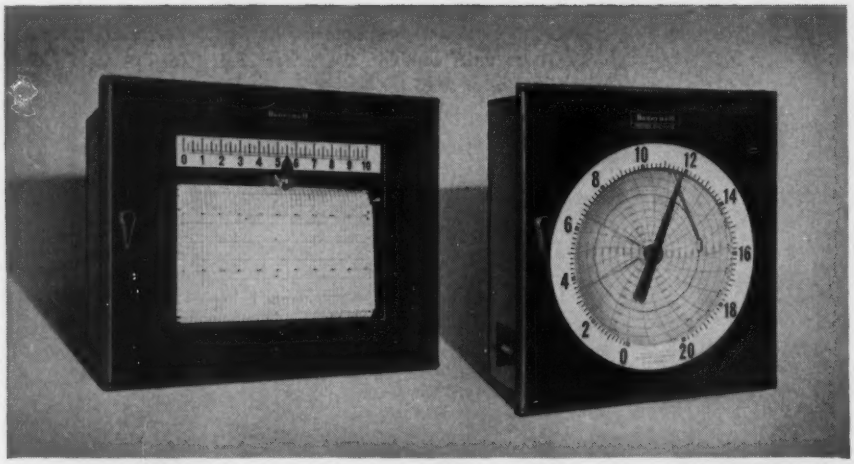
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854 • *SALES OFFICES:* • Albuquerque, N. M. • Boston • Buffalo • Charlotte, N. C. • Chicago • Cleveland • Dallas • Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D. C.

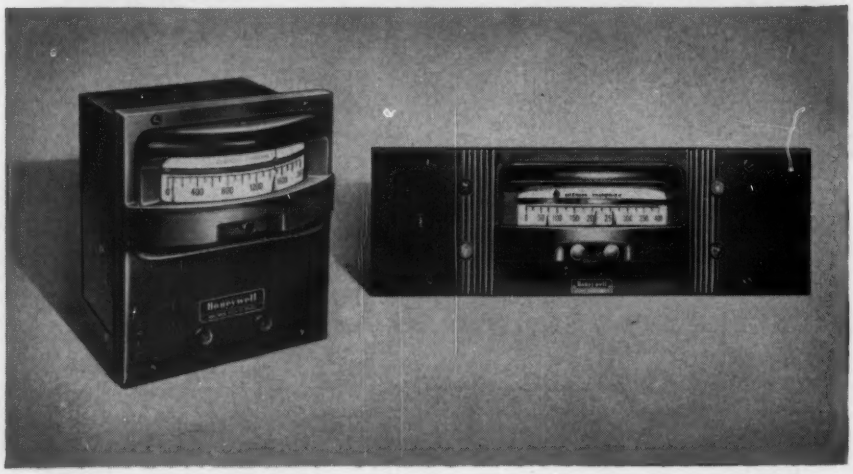
• *for accuracy, versatility, price*

The Precision Class 15 Line of *ElectroniK* instruments has calibrated accuracy within ±.25% of scale span. Models include strip and circular chart recorders, Precision Indicators, circular scale indicating controllers, Vertical Scale Precision Indicator. Electric and pneumatic control from simplest to most complex types. Multi-point monitoring or recording of 2 to 400 separate inputs.

...Let your application decide



The Special Class 14 Line of *ElectroniK* instruments is calibrated to an accuracy of ±.5% of scale span . . . priced lower than the Precision line. Includes strip chart and circular chart recorders and recording controllers, also circular scale indicating controllers. Electric control of the contact, time-proportioning or position-proportioning type is available.



Millivoltmeter Instruments give dependable and accurate service, at low cost. High-resistance galvanometer circuit minimizes effects of varying length of extension wires. Plug-in unit design speeds servicing. *Pyr-O-Vane* controllers, in either horizontal or vertical case, give snap-action electronic vane control or pulse-type time-proportioning control.

which Honeywell instrument

fits your needs

GOT a temperature measurement or control job to handle? There's no need to "shop around." For from *one* source—Honeywell—you can be sure of getting exactly the right instrument to fit your needs.

This is the time-saving—and money-saving—way to choose instruments. You can choose from the most complete, most diversified line of pyrometric instruments on the market. Your selection can hit the application right on the button—giving you the performance you need at the price that fits your budget.

For the peak in precision and versatility, there's the "Precision" *ElectroniK* line. This is the pioneer "continuous balance" electronic instrument that thousands of plants and laboratories have used for many years. It's available in eleven basic models, and can provide automatic control action from the simplest to the most advanced types.

For less exacting applications, a new series of instruments—the "Special" *ElectroniK* line—is now available. They provide many of the forms of automatic control you can get with the "Precision" line. And they cost less . . . bringing *ElectroniK* performance within the reach of even wider areas of application.

For simplified indicating control, Honeywell offers a line of economical millivoltmeter instruments . . . *Pyr-O-Vane* controllers, with a variety of electric control forms . . . and *Protect-O-Vane* controllers for excess temperature safety cut-off.

Your local Honeywell engineer will be glad to help you determine which type of instrument best fits the needs of your own application.

Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

Hall Industrial Water Report

VOLUME 4 APRIL 1956 NUMBER 2

Corrosion—a Plague on All Our Houses

—presents problems as varied as industry, for all industry uses water in some way and all water causes corrosion to some extent. Thirty years of experience in thousands of individual plants enables Hall Laboratories to apply to current problems the most practical techniques for control of corrosion, many of them developed by Hall research and engineering.

Condensate System Saved

On his first visit to a new client, a hospital in Virginia, Hall engineer C. F. Raines encountered corrosion of the black iron condensate system so "terrible" that two men were kept constantly busy just replacing fittings and piping.

Both pitting and etching of the steel were occurring, suggesting that both dissolved oxygen and carbon dioxide were factors in the corrosion. However, the oxygen was not readily accounted for.

Raines examined the feedwater heater and found there was no way for the steam from the deaerating section to pass to the vent condenser. A tee had been installed in the line to take care of this, but instead had been used for a condensate line from the laundry. By proper rearrangement of connections, adequate venting was obtained as had originally been intended.

Additional changes included feeding 1 ppm. of Hagafilm® to the boilers to inhibit return line corrosion, and Santosite to react with residual oxygen not removed in the feedwater heater. Condensate line corrosion became negligible. Instead of replacing the entire condensate system at a cost of several thousand dollars, the plant now protects the system chemically at a cost of 17 cents a day.

Gasket "Corrosion" Problem Quickly Solved

Attack of boiler handhole gaskets at the pressure points of the locking clamps—center top and center bottom—on the sealing surfaces was experienced at a plant in West Virginia serviced by Hall engineer Wm. J. Reese.

At first it was thought that a highly-concentrated solution of caustic had dissolved the asbestos packing.

This possibility was rejected when it was concluded, after careful examination, that the gaskets had been distorted due to excessive pressure applied to the extremities of the minor axis in order to prevent leakage at the ends of the major axes. Subsequent investigation revealed the machined surfaces of the seats did not overlap properly at the ends of the minor axes, and the high points coincided with the areas of attack on the damaged gaskets. Refinishing the gasket seats eliminated the problem.

Bacterial Growths Get the Air

Severe corrosion under rusty deposits in an ammonia condenser prompted a food processing plant in Ohio to call on Hall Laboratories for help. Suspecting iron-fixing bacteria to be responsible for the hydrous ferric oxide deposits, Sales Engineer J. M. Harvey sent samples of water and a sample of wet deposit to Pittsburgh for investigation.

Bacteriological examination showed both iron-fixing and sulphur bacteria in the well water. Chemical examination showed the water to be high in bicarbonate hardness, with approximately 2 ppm. of iron and manganese in solution. Chlorination of the water was needed to kill the living organisms, but this would oxidize the iron and manganese and cause them to deposit, even though the iron-fixing bacteria which had been causing this were eliminated. Harvey met this dilemma by recommending stabilization of the calcium carbonate, iron, and manganese by continuous feed of threshold amounts of Calgon directly to the bottom of the well, followed by intermittent addition of hypochlorite to the discharge side of the well pump.

But this plant had everything. Now a different problem developed with an accumulation of slime in the condensers. In a new sample of wet deposit, Hall Laboratories found sulfate-reducing bacteria. Since these peculiar "bugs" thrive only in the absence of oxygen, continuous aeration of the well water was recommended to supplement the intermittent chlorination.

Operating experience has proved that aeration has been decidedly beneficial. There have been no condenser outages for cleaning, whereas formerly cleaning was necessary several times each summer.

These Whistles a Bargain, Sir!

In a Michigan plant the original soot blowing system lacked the whistles normally installed. When the steam valve was shut off after soot blowing, the vacuum produced drew gases from the ash pit through the drain into the piping. Severe corrosion resulted. Correction involved installation of the whistles to prevent vacuum by acting as vents.

Ben Franklin's advice to consider alternatives before buying a whistle lest disappointment prove payment too dear for the choice could thus be answered, "*These* whistles were a bargain, Mr. Franklin."

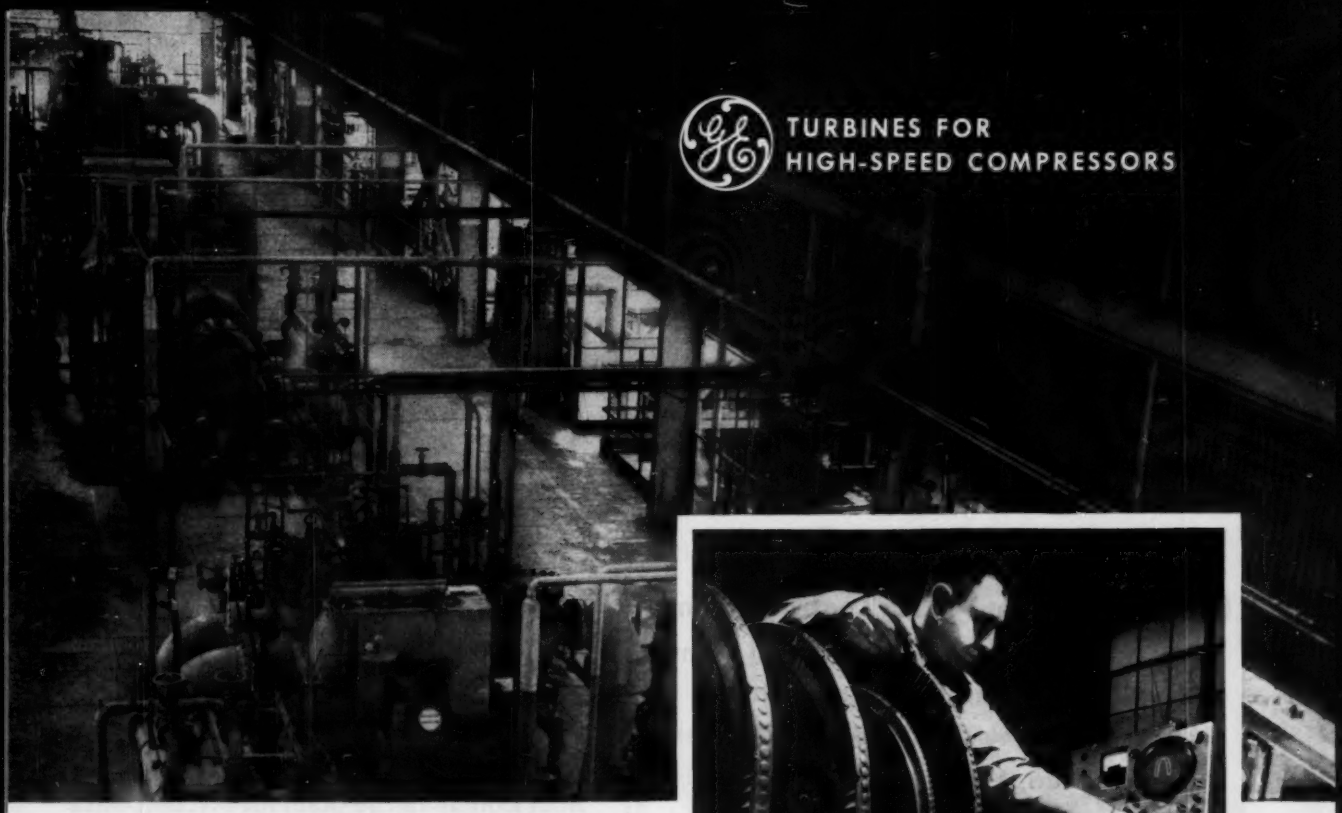
Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

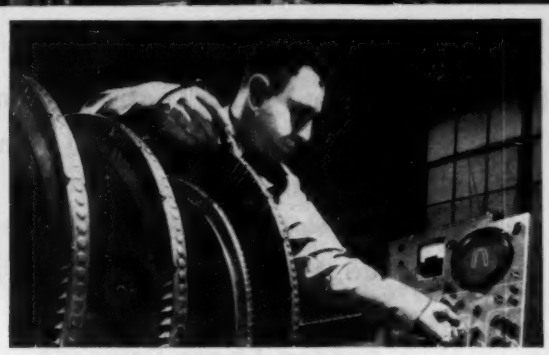
Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

TURBINES FOR
HIGH-SPEED COMPRESSORS



Six General Electric high-speed turbines operate on 'round-the-clock compressor service at Gulf refinery in Port Arthur, Texas.



For greater bucket reliability, G-E engineer locates "quiet zone" of resonant vibration in buckets to assure that steam-impact frequencies and natural bucket frequencies do not coincide.

MORE THAN JUST RATING AND SPEED . . .

You buy reliability when you specify a G-E High-speed Turbine

IN PROCESS INDUSTRIES, where outages can cost upwards of $20,000 a day, turbine reliability is a major consideration when specifying compressor and blower drives. General Electric mechanical-drive turbines have built-in reliability features that can assure minimum down-time and greater profits for your operation:

HEAVY-DUTY ROTORS are machined from a single forging to withstand years of continuous high-speed operation. The rotor is completely balanced without buckets, then balanced again as each wheel is bucketed.

EXTERNAL DOVETAIL BUCKETS are attached to wheel rims with machine fit. External construction assures proper force distribution at high speed, gives better rotor protection from moisture erosion.

LARGE PRESSURE PAD BEARINGS furnished on all G-E high-speed turbines minimize shaft vibration. Generous bearing surfaces assure low unit loading for ample lubrication and minimum wear during turbine start-up.

FLANGED CONNECTIONS provide safer oil piping joints, eliminate potential fire hazards. Oil piping gages and pressure switches are arranged to reduce possibility of oil spray on hot turbine parts.

CARBON PACKING used in addition to metallic labyrinth packing assures efficient steam sealing on G-E high-speed turbines. Carbon rings in external packing boxes are non-seizing, have high mechanical strength in the small sizes used.

POSITION RESTORED GOVERNING SYSTEM is designed for close accurate governing in response to load requirement and the slightest variations in steam conditions. Governor will operate with any recycle controlling system.

These are but a few of the important design features that account for consistent reliability of General Electric high-speed mechanical-drive turbines. For further information, contact your nearest G-E Apparatus Sales Office, or write for new bulletin GEA-6232, General Electric Company, Section 241-5, Fitchburg, Mass.

Progress Is Our Most Important Product

GENERAL ELECTRIC

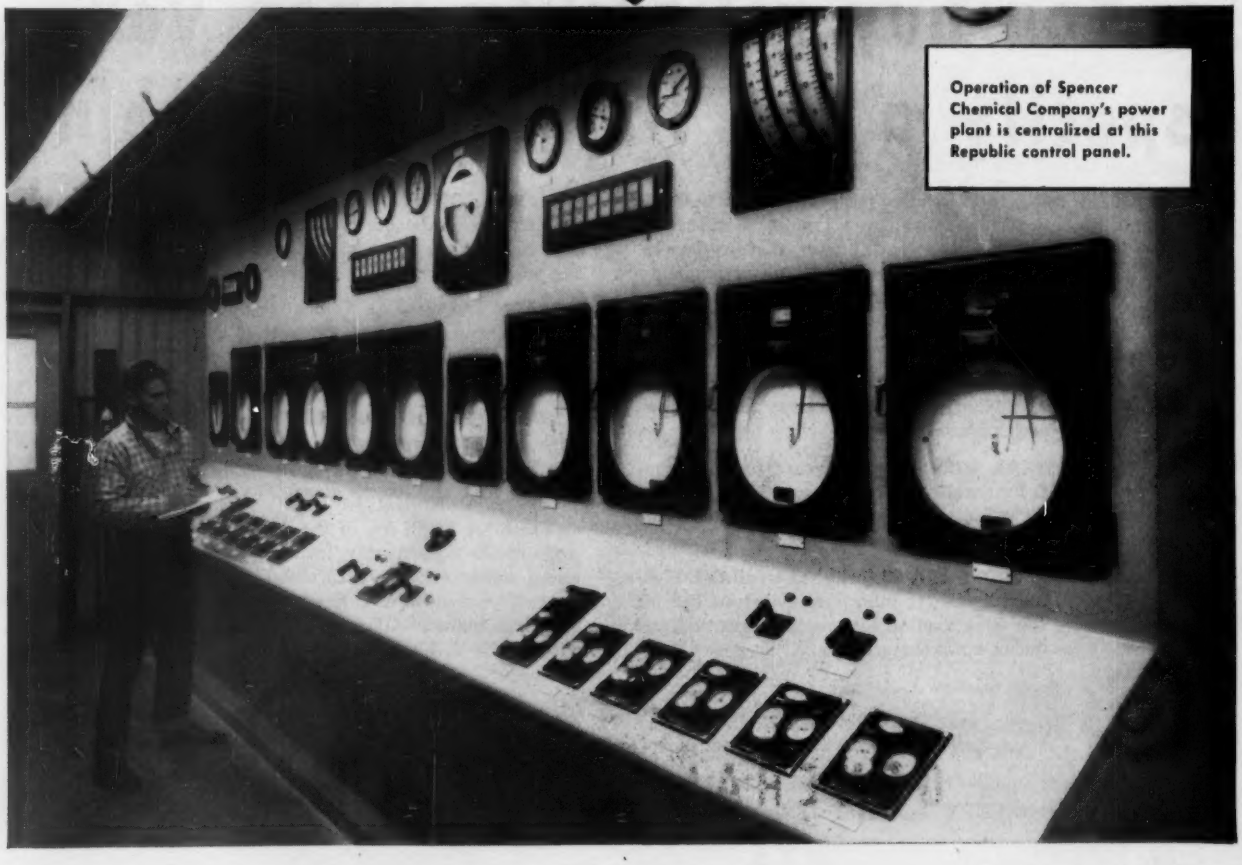
Automatically Controls Outdoor Steam Plant

FOR FAST LOAD CHANGES

REPUBLIC Combustion Control System at New Texas Chemical Plant Automatically Prevents Flame-Outs and Over-Firing on Wide Load Swings, Enables Boilers to Meet Sudden Steam Demands Smoothly and Safely

Extremely large and fast load changes make combustion efficiency only part of the combustion control job at Spencer Chemical Company's new Orange Texas polyethylene plant. The control system operates two gas fired 60,000 lbs. per hour boilers in the plant for fast response to load changes without over-firing or losing ignition on wide load swings.

To prevent over-firing when there is a sudden demand for more steam, a gas



Operation of Spencer Chemical Company's power plant is centralized at this Republic control panel.

safety regulator keeps the fuel valve in step as draft fans increase speed. By compensating for the unequal speed of response of the two boiler auxiliaries, the control system maintains proper conditions *even while loads are changing.* If steam demand falls below minimum steam conditions, a minimum gas pressure is maintained automatically at the burners, regardless of the number in service, to prevent flame-outs. In addition to safer operation, these features also mean continuous combustion efficiency for extra fuel savings.

When your problem is combustion control—for a small power plant or a central station—it will pay you to contact Republic. At your service is an experienced engineering staff that can design the control system that exactly meets your needs—specialized as they may be. This combination of expert design and modern Republic equipment can assure you of dependable, efficient control of your power plant.

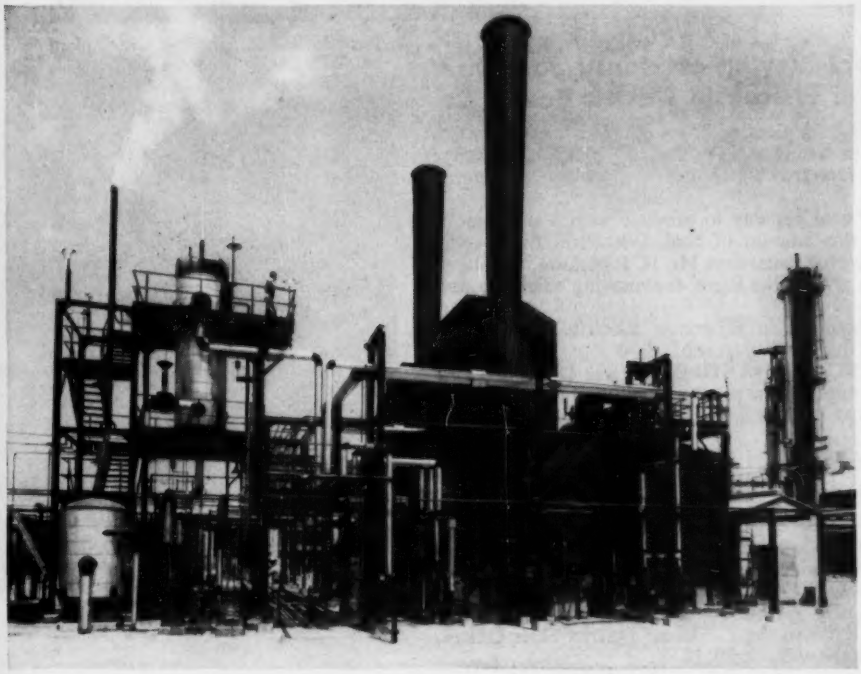
REPUBLIC

Automatic COMBUSTION CONTROLS

(pneumatic or electronic)

- ★ **FOR ALL SIZES AND TYPES OF BOILERS**
- ★ **FOR ALL LOAD CONDITIONS**
- ★ **FOR ALL METHODS OF FUEL FIRING**
- ★ **FOR ANY ARRANGEMENT OF DRAFT**

Write for details



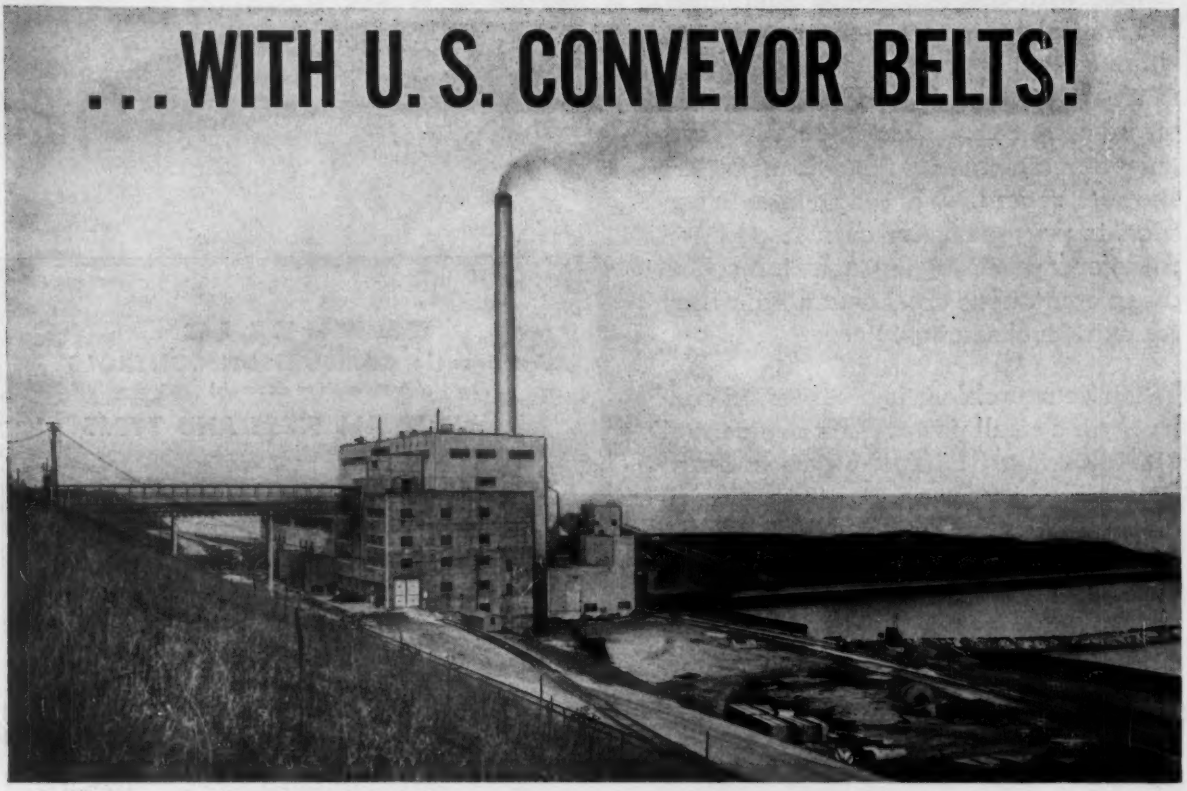
THE ENTIRE POWER PLANT,

except for the control panel is outdoors. Panel board is housed in sheet metal building at right. The two 60,000 lbs. per hour gas fired boilers, operating at 415 psi and 750°F., furnish steam to compressors used in converting ethylene gas into polyethylene. This is new miracle plastic that is used for products ranging from "squeeze" bottles to electrical insulation.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

MOVING 4100 TONS OF COAL PER DAY

...WITH U. S. CONVEYOR BELTS!



Partial view of new Oak Creek plant of Wisconsin Electric Power Co.

"'U. S.' gives us best coal-moving efficiency possible," says the cost engineer of Wisconsin Electric Power Co.

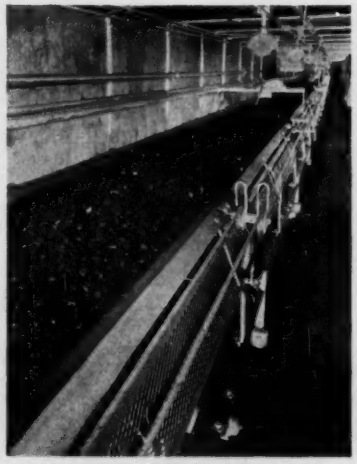
The immense new Oak Creek generating plant of Wisconsin Electric Power Co. is the largest and most modern in the entire state. Total planned capacity: 500,000 kilowatts... to feed the ever-growing demands of Wisconsin homes and industries.

It takes well over 4100 tons of coal per day to produce such a tremendous amount of power. And to move this amount of coal, Wisconsin Electric has installed United States Rubber Conveyor Belts. Says Mr. H. Jorgenson, the plant's cost engineer, "the U. S. belts help give us the finest coal-moving efficiency possible."

"U. S." products are not newcomers with Wisconsin Electric. "U. S." belts have been working there for more than twenty years.

"PULVERIZED COAL HAS TO BE HANDLED LIKE DYNAMITE," says Mr. Jorgenson. That's why throughout the plant you will find fire protection equipment of the most advanced type, and U. S. Peerless® is the brand of water hose hooked up to the system.

"THE ENTIRE GENERATING SYSTEM IS ALIVE WITH CONSTANT EXPANSION AND CONTRACTION, BECAUSE OF MANY HEAT CHANGES AND PRESSURES." That's why Wisconsin Electric cushions its power plant piping systems with U. S. Expansion Joints—to counteract the destructive effects of expansion, contraction and misalignment. Utility companies throughout the country not only depend on the *excellence* of "U. S." products but on the "constant vigilance" of "U. S." engineers in periodically checking up on "U. S." product performance, plus giving engineering and technical help whenever needed. Get in touch with any of the 27 "U. S." District Sales Offices, or write to us at Rockefeller Center, New York 20, N. Y.



"U. S." 48-inch conveyor belt.

US RUBBER

Mechanical Goods Division

United States Rubber

Tomorrow's fully supercharged Generator

New cooling principle fills important need as generating units grow larger

● This new design makes larger ratings practical in tomorrow's power stations.

Reports on test generator — the first with both rotor and stator cooled by supercharging — show low temperature operation and exceptional electrical characteristics, including high reactances.

This supercharged generator design has now proved its advantages in size and performance over any previously built units.

We will be glad to supply you with complete information on units of this type. Call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-4737

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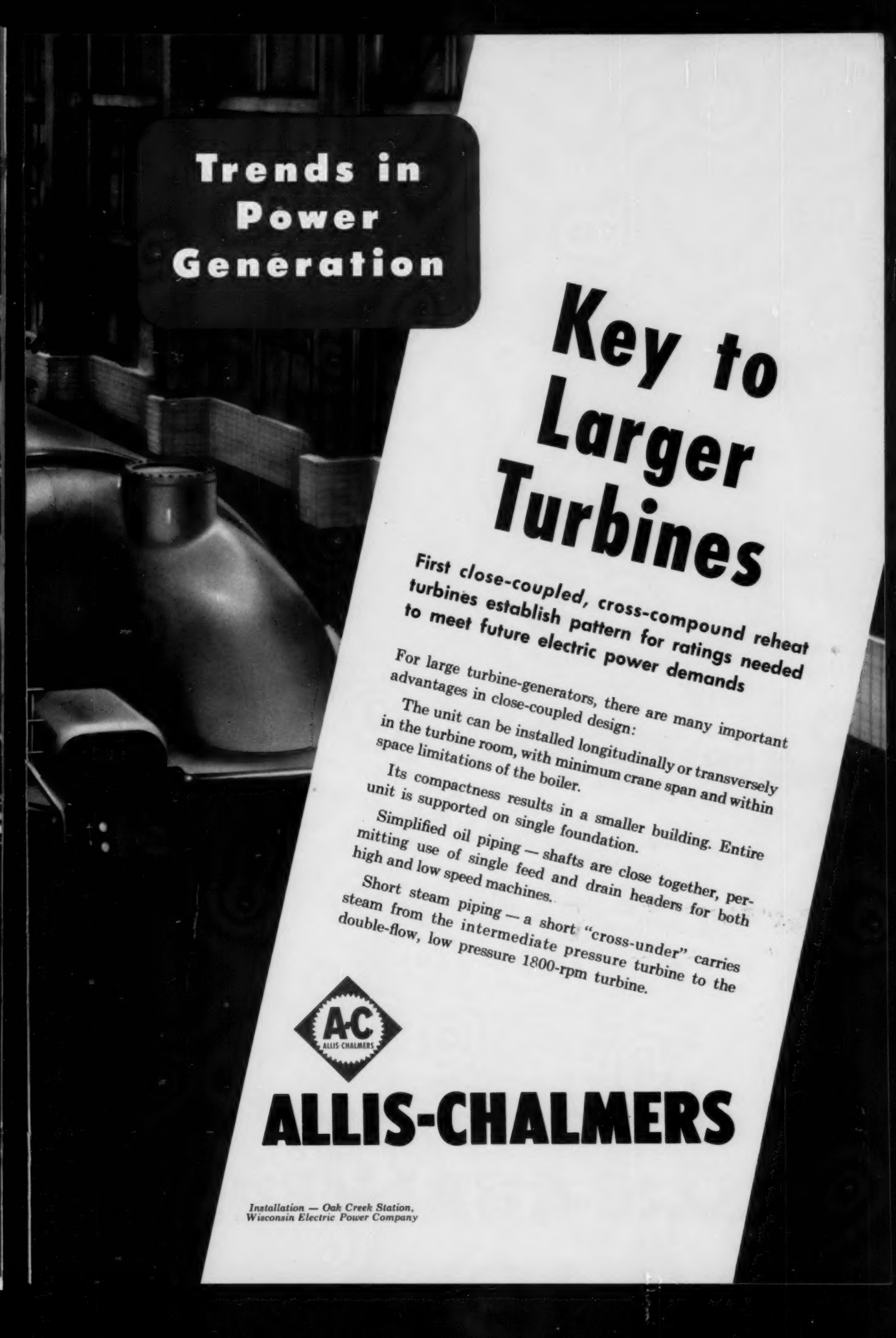


Trends in Power Generation

Key to Larger Turbines

First close-coupled, cross-compound reheat turbines establish pattern for ratings needed to meet future electric power demands

For large turbine-generators, there are many important advantages in close-coupled design:

The unit can be installed longitudinally or transversely in the turbine room, with minimum crane span and within space limitations of the boiler.

Its compactness results in a smaller building. Entire unit is supported on single foundation.

Simplified oil piping — shafts are close together, permitting use of single feed and drain headers for both high and low speed machines.

Short steam piping — a short "cross-under" carries steam from the intermediate pressure turbine to the double-flow, low pressure 1800-rpm turbine.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Installation — Oak Creek Station, Wisconsin Electric Power Company

Choose Condenser Shape to Simplify Plant Layout

Get high operating efficiency of Multi-Steam-Path Condensers in Round, Oval or Rectangular shape

This adaptability of Allis-Chalmers condenser design adds flexibility to plant layout without sacrifice of efficiency. This means freedom for you in planning future power stations.

Multi-steam-path design makes all tubes completely effective by directing the steam to even the remote sections of the condenser, thereby producing a high vacuum.

Steam, penetrating all parts of the condenser, keeps condensate temperature high and drives off dissolved oxygen.

This combination of high vacuum, high condensate temperature and good deaeration means high operating efficiency.

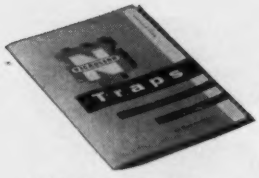
Talk over the special requirements you have in mind for future stations with Allis-Chalmers engineers. Call your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Nicholson *steam trap* quality *gives you* . . .

extra stamina for severest service



Write, today, for your copy of new Bulletin 10-55—for detailed information.

Nicholson quality . . . throughout . . . means the extra strength, extra capacity, extra stamina that never let down. And, Nicholson quality pays off, when it comes to discharging condensate and air from steam distribution lines and equipment . . . most efficiently, dependably, economically.

- **powerful valve action—big husky bellows.**
- **positive shut-off—finely ground valve and seat.**
- **high capacity—effective use of large orifice.**
- **each unit service tested—with steam.**

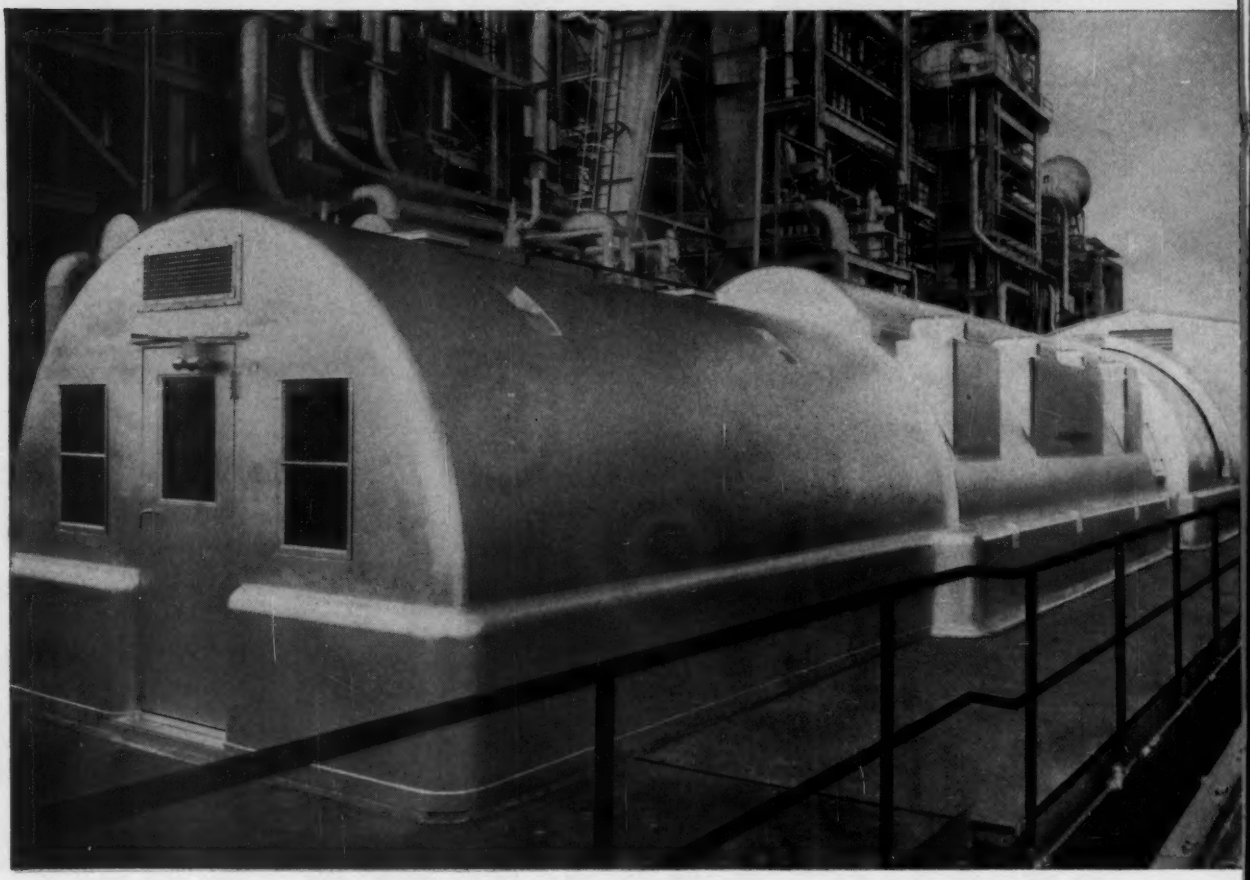
When less than the best won't do, specify Nicholson.

NICHOLSON

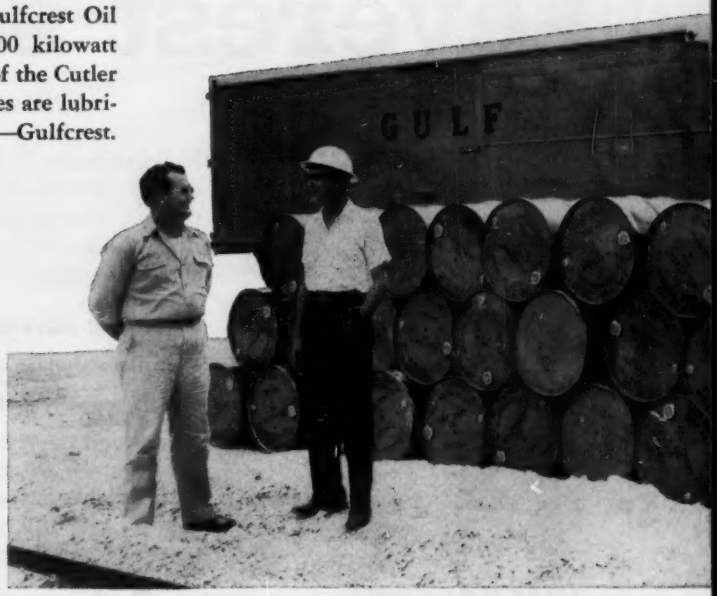
W. H. NICHOLSON *and Company*

TRAPS • VALVES • FLOATS • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY

14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 98 PRINCIPAL CITIES



Part of the 100-drum shipment of Gulfcrest Oil which will lubricate the new 150,000 kilowatt turbine. This brings the total output of the Cutler Plant to 370,000 kilowatts. All turbines are lubricated with the finest in turbine oils—Gulfcrest.

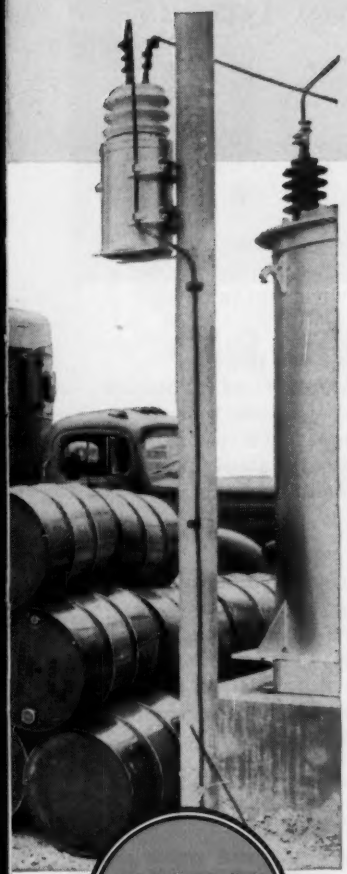


THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS

Past performance proved it best...

GULFCREST OIL

selected to lubricate another big turbine at Florida Power & Light Company



When the Florida Power & Light Company recently installed the new 150,000 kilowatt General Electric turbine in its ultra-modern Cutler Plant, the choice of a lubricant was no problem. The outstanding past performance of Gulfcrest in the four other units in the plant made it a natural selection.

Gulfcrest Oil has a background of superior performance in other Florida Power & Light Company plants, and in scores of other prominent utilities throughout Gulf's marketing territory. Here's why:

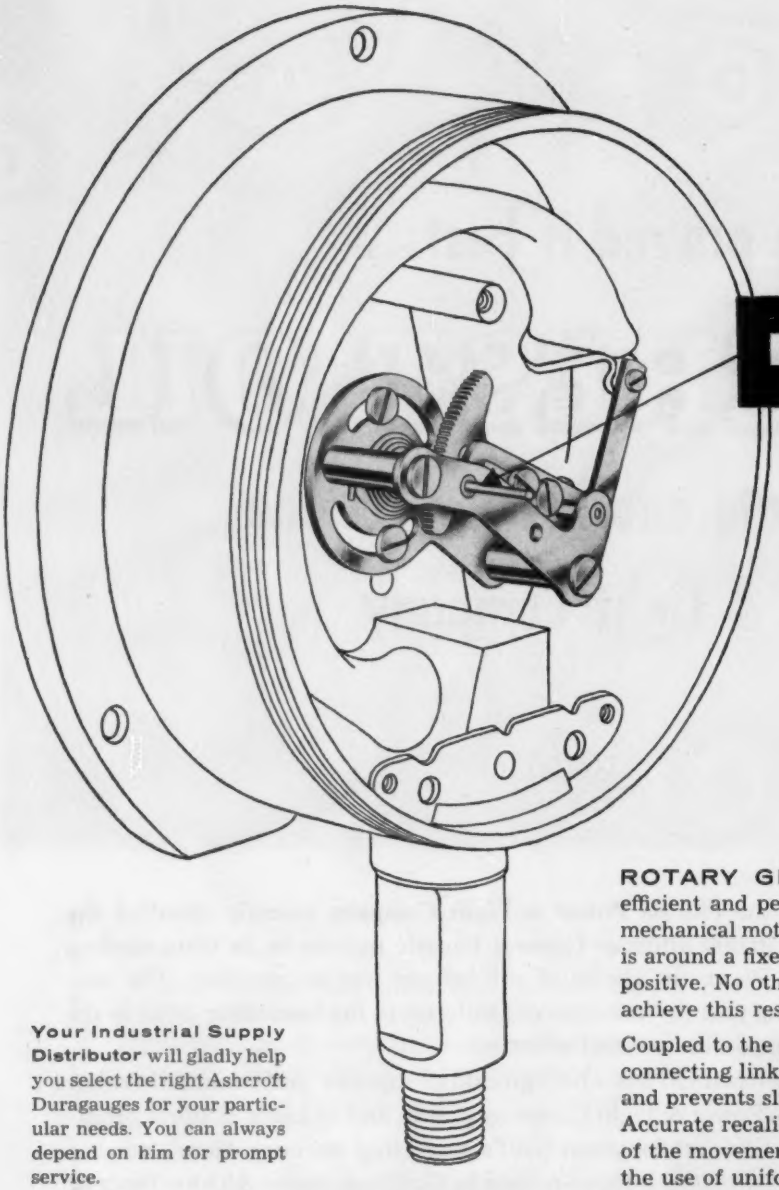
Gulfcrest Oil is super-refined by Gulf's exclusive Alchlor Process, which removes the unstable hydrocarbons that remain after normal refining. This discarded portion, if allowed to remain in a turbine oil, accelerates oxidation, increases neutralization number, forms sludge and harmful acids.

So to insure safe, long-lasting protection for your turbines, specify Gulfcrest—the world's finest turbine oil.

Call a Gulf Sales Engineer today and have him recommend the proper grade of Gulfcrest Oil to meet the specific requirements of your turbines. Consult the telephone directory for the number of your nearest Gulf office.

GULF OIL CORPORATION • GULF REFINING COMPANY
1822 Gulf Building, Pittsburgh 30, Pa.

GULF



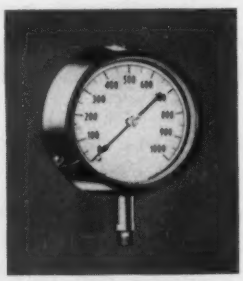
Why does the MOVEMENT in the ASHCROFT DURAGAUGE outperform all other types?

ROTARY GEARED MOTION, the most efficient and perfect method of transmitting mechanical motion ever developed. Because rotation is around a fixed center, pointer position is always positive. No other type of movement can ever achieve this result.

Coupled to the movement is a one-piece connecting link that guarantees correct calibration and prevents slippage or parting under tension. Accurate recalibration is easy from front or rear of the movement. Universal adjustability permits the use of uniformly graduated dials, thereby facilitating maintenance.

The Ashcroft Duragauge is available with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. There are case designs and materials, Bourdon tube materials, pressure ranges and dial sizes to meet your service conditions exactly. Save time, trouble and money. Specify the pressure gauges of highest sustained accuracy and durability – Ashcroft Duragauges.

Your Industrial Supply Distributor will gladly help you select the right Ashcroft Duragauges for your particular needs. You can always depend on him for prompt service.

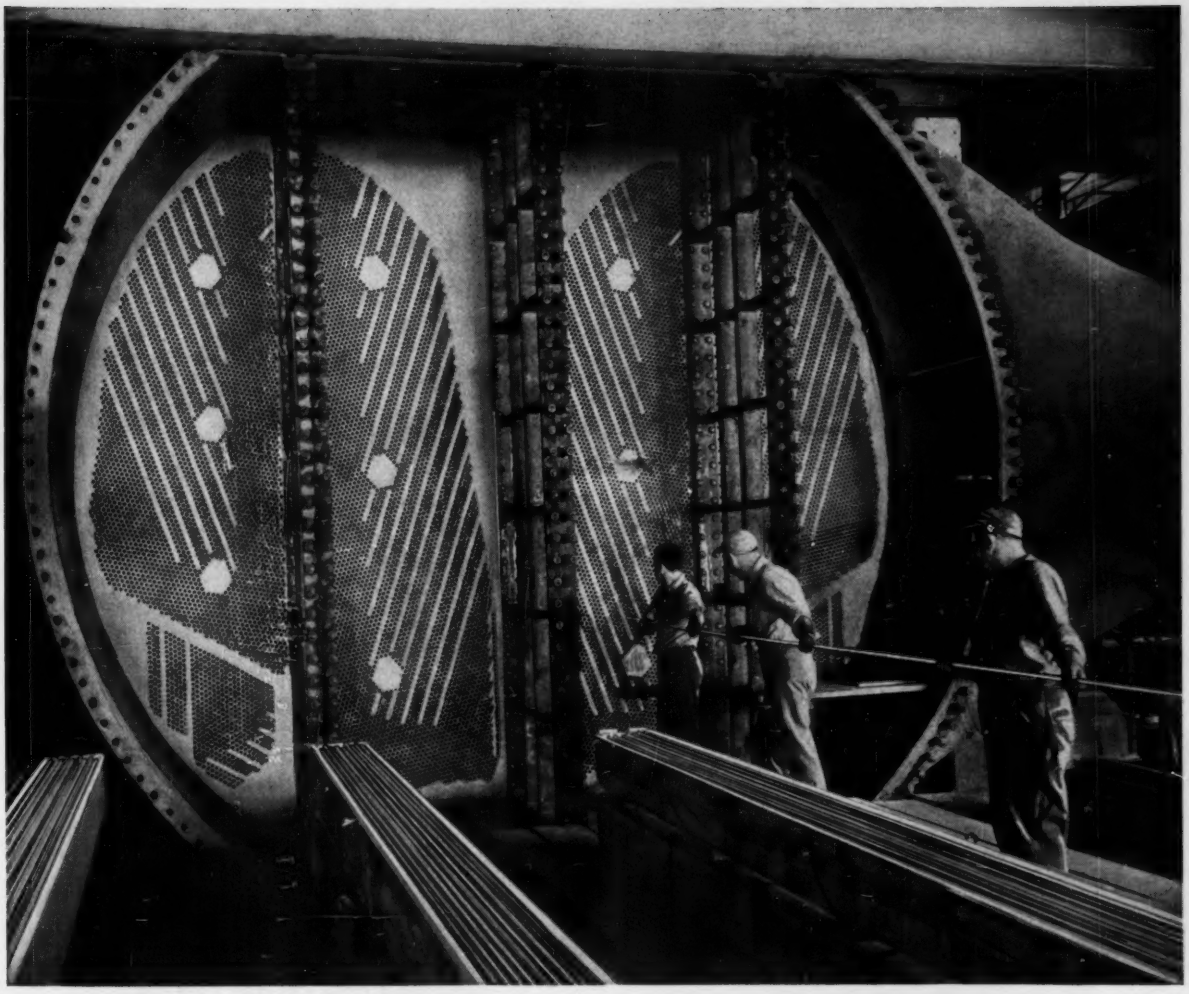


In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*



IN FOR A BIG HEAT-TRANSFER JOB

...AND MANY YEARS OF SERVICE FROM

CHASE® ANTIMONIAL ADMIRALTY TUBE!

Remove 988 Btu's per pound of steam! Condense 1,046,830 pounds of steam per hour! Cool with raw lake water! That's the job of a single-pass condenser for a Great Lakes power and light company.

And Chase Antimonial Admiralty was selected for the condenser tubes in this installation with many years of trouble-free service anticipated. You see, Chase Antimonial Admiralty condenser tubes have *virtually eliminated* tube failures caused by dezincification. Perfect alloying and tempering provide freedom from season cracking and permit easy rolling into tube sheets. And rigid quality controls at the mill assure tube as flawless as science can make it.

Make sure your new and replacement condenser tube installations will *really* give long service. Insist on Chase Antimonial Admiralty!

Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

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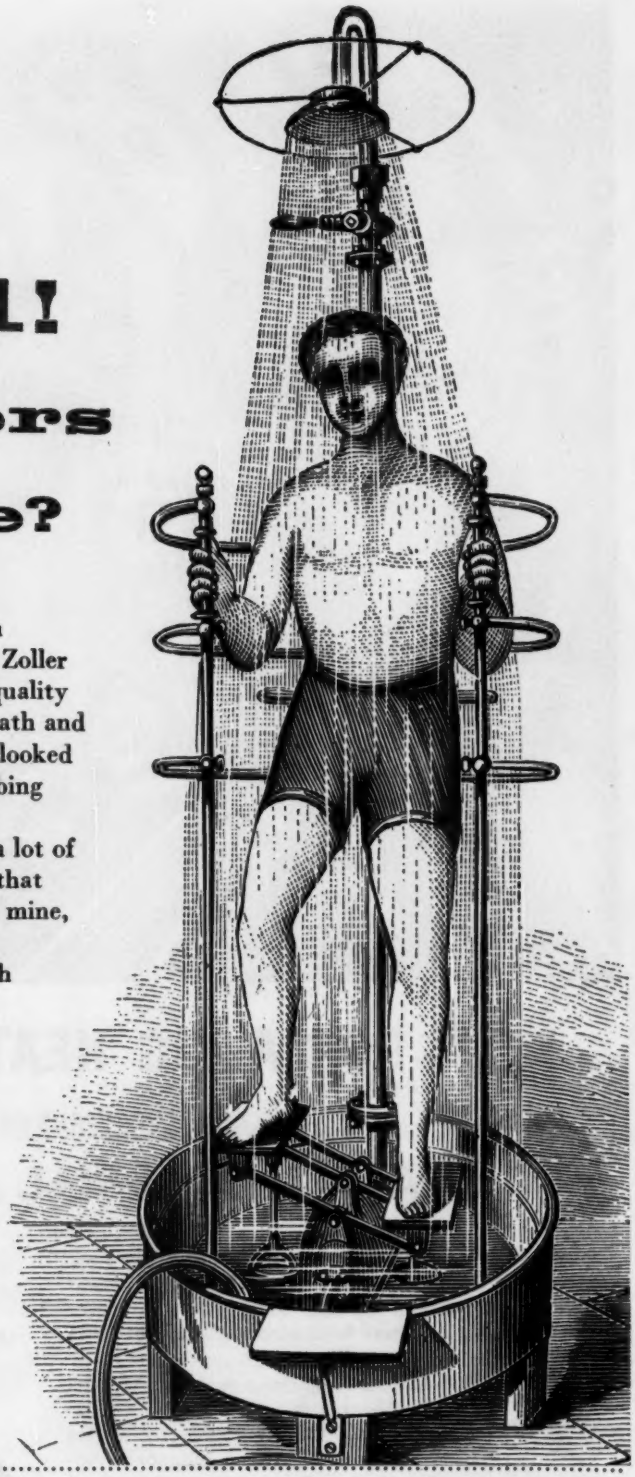
Milwaukee • Minneapolis • Newark • New Orleans • New York • Philadelphia • Pittsburgh • Providence • Rochester • St. Louis • San Francisco • Seattle • Waterbury

Egad!

will wonders never cease?



Patented! Warranted! A marvel of modern ingenuity! Yes, back in 1886, when Bell & Zoller first started marketing their famous high-quality coals, this combination leg-pump shower bath and morning workout was all the rage—and it looked like the new-fangled fad of "indoor" plumbing was here to stay!

Yes, we've come a long way, and made a lot of changes since then. But there's one thing that hasn't changed. 70 years ago we set out to mine, process and deliver the best possible selection of free-burning, high-heat, low-ash coals—by the best, low cost, most modern methods available.

And we're still doing that job in 1956!

★ ★ ★

You know these coals by the famous brand names of ZEIGLER, MOSS HILL, ORIOLE, MURDOCK, LIBERTY SMOKELESS, BUCKHORN... and you can be sure of fast, low cost delivery through your nearest Bell & Zoller office—today!

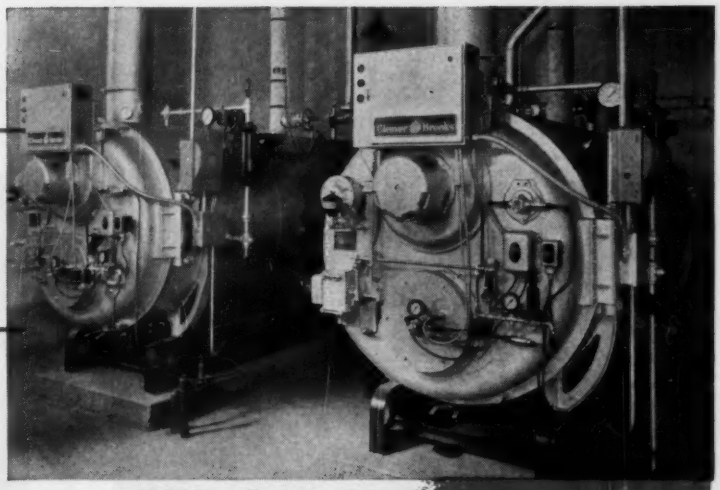
Bell & Zoller Coal Company

70 YEARS OF SERVICE TO COAL USERS

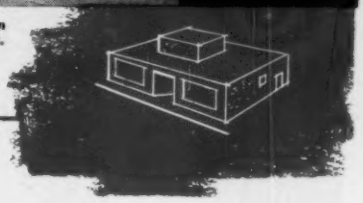
BELL BUILDING, CHICAGO 1, ILLINOIS

Detroit • New York • St. Louis • Minneapolis
Omaha • Milwaukee • Louisville • Washington, D.C.
Terre Haute, Ind. • Mount Hope, W.Va.

18 sizes
110 models
15 to 600 hp

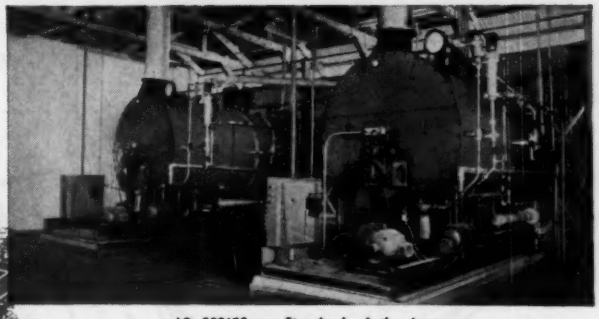


CB SERIES — The ultimate in compact, quiet-running boilers. Sizes: 15 to 150 hp.

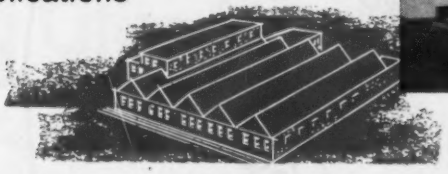


yours from Cleaver-Brooks

the broadest line of cost-saving "packaged" boilers—for hundreds of applications



LR SERIES — Standard of the industry for hot water or steam service, for heating or processing. Sizes: 200 to 600 hp.



THE two installations above are representative of Cleaver-Brooks' broad range of standard models. The wide choice makes planning and selection of a boiler for your specific needs — large or small — a simple, time-saving procedure.

Your nearby Cleaver-Brooks representative, with years of specialized boiler experience, can be of real service to you. Working with you and your engineers, he can help you to find ready answers to questions of size, loads, present and future steam or hot water needs, space and equipment arrangement. Where local conditions dictate, oil, gas or combination oil/gas firing can be selected for greatest savings. And once installation is completed, arrangements are made for factory-supervised starting and training your operator.

Keep in mind, too, the many fuel and maintenance-saving advantages of four-pass design with forced draft . . . the standard equipment electronic combustion controls which assure continuous, safe operation.

Cleaver-Brooks boiler owners enjoy all these advantages and share in the combined application engineering experience of more than 19,000 individual boiler installations. Put this experience to work for you. Cleaver-Brooks Company, Dept. E. Keefe Ave., Milwaukee 12, Wis., U.S.A., Cable Address: CEEBEEWEST — all codes.

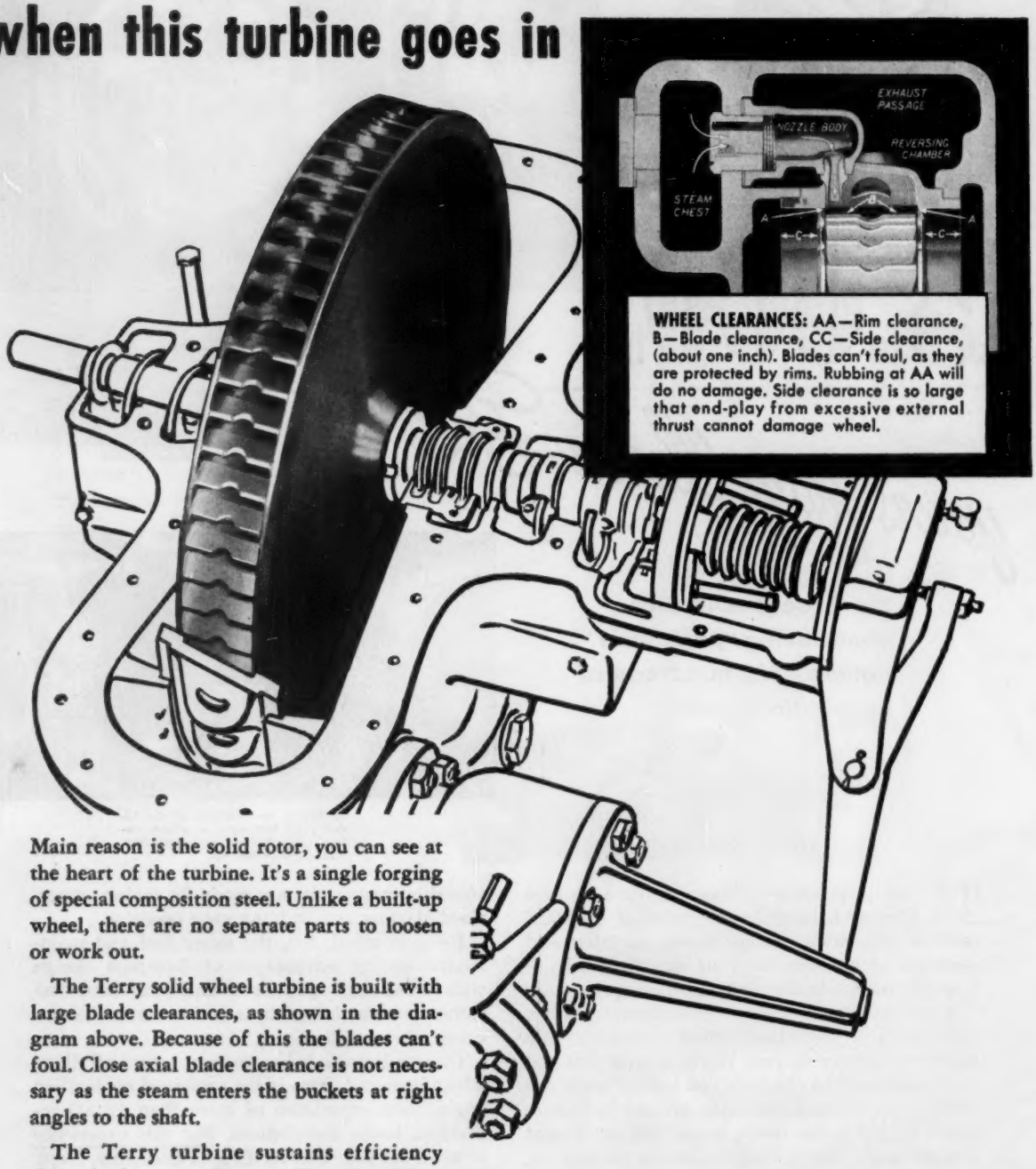
See the classified pages of your phone directory for name of nearest representative. Send us your name to receive regular issues of the new Cleaver-Brooks Bulletin, or write for newest literature.

Cleaver Brooks®

TWENTY-FIVE YEARS OF LEADERSHIP
BY THE ORIGINATORS OF THE SELF-CONTAINED BOILER

WHY TROUBLE GOES OUT

when this turbine goes in



WHEEL CLEARANCES: AA—Rim clearance, B—Blade clearance, CC—Side clearance, (about one inch). Blades can't foul, as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large that end-play from excessive external thrust cannot damage wheel.

Main reason is the solid rotor, you can see at the heart of the turbine. It's a single forging of special composition steel. Unlike a built-up wheel, there are no separate parts to loosen or work out.

The Terry solid wheel turbine is built with large blade clearances, as shown in the diagram above. Because of this the blades can't foul. Close axial blade clearance is not necessary as the steam enters the buckets at right angles to the shaft.

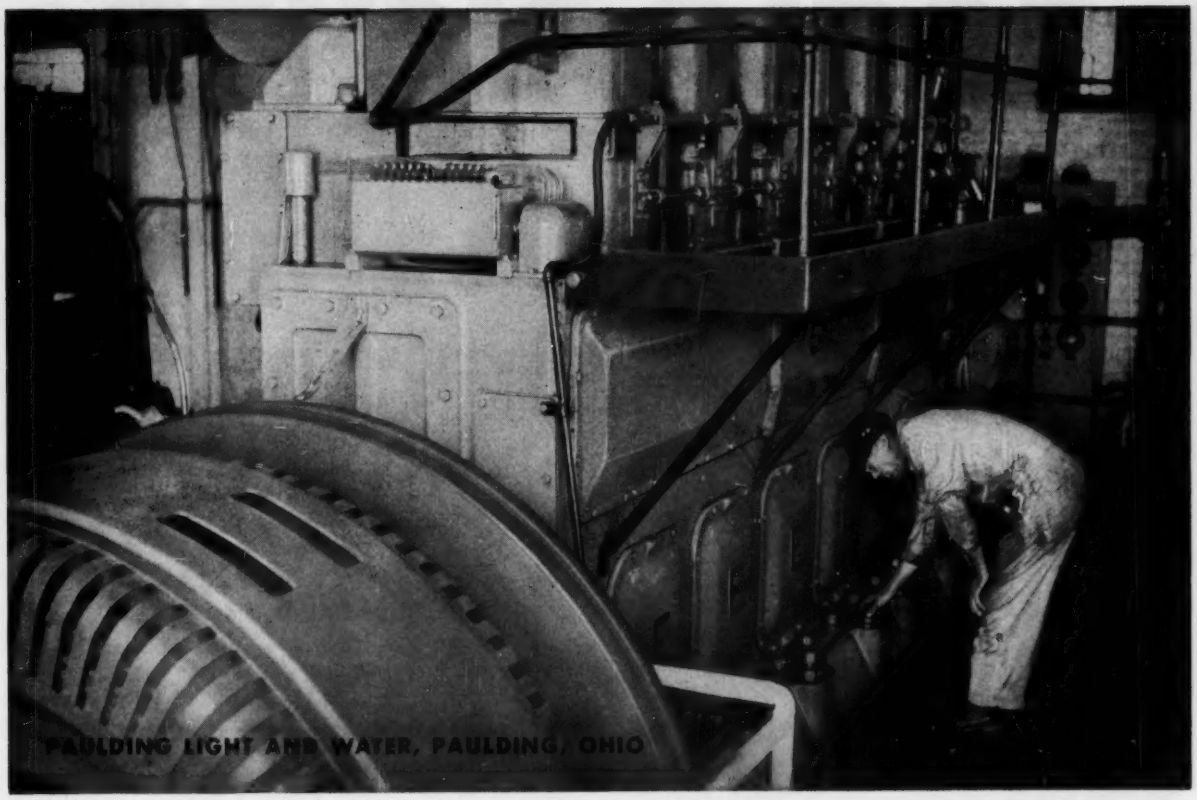
The Terry turbine sustains efficiency through the years. Reason: The power producing action of the steam takes place on the curved surfaces at the back of the buckets, so blade wear which might occur is of little consequence.

Bulletin S-116 tells more about these *"Work Horses of Industry."* Send for a copy today.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1202



"16,587,402 H. P. hours without oil change using Cities Service C-300 Lube Oil!"

1000 KW Enterprise uses only one gallon of oil in 23,205 BHP hours, has no oil reclaimer.

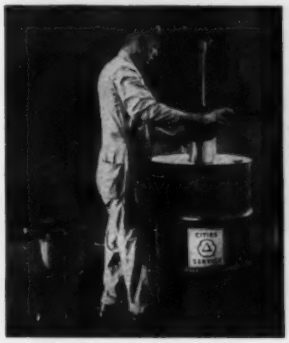
The main part of the power output of Paulding Light and Water Company is developed by its dual-fuel, 1000 KW Enterprise Unit.

Mediocre performance can't be tolerated at Paulding . . . the power load is running twice that of seven years ago!

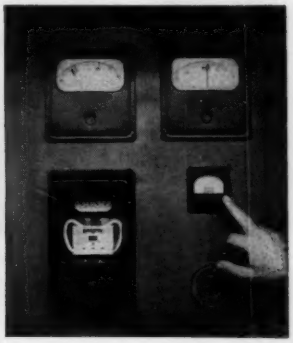
"Fortunately," says Superintendent James J. Leslie, "performance is tops—and much of the credit is due Cities Service C-300 Lube Oil. We really pile up hours with C-300 . . . and still get excellent engine life. I've never had the head off the Enterprise since it was first installed in 1953, yet compression, fire pressure, and fuel economy are still very good.

"We've actually logged up to 16,587,402 H. P. hours without an oil change. We use only 1.5 gallons of C-300 Lube Oil per day, which amounts to 23,205 brake-horsepower hours per gallon . . . and that's with no oil reclaimer! I'd recommend Cities Service to any power plant."

If you're interested in Mr. Leslie's recommendation, talk with your Cities Service Lubrication Engineer. He can tell you of other outstanding case histories. Or write: Cities Service Oil Co., Sixty Wall Tower, New York 5, N. Y.



Electric Service Goes Hand in Hand with Cities Service at Paulding Light & Water. Paulding's Enterprise dual-fuel power unit gets 23,205 BHP hrs. for every gallon of Cities Service C-300 Oil that's consumed. Oil changes are made about every 11,000 hrs.



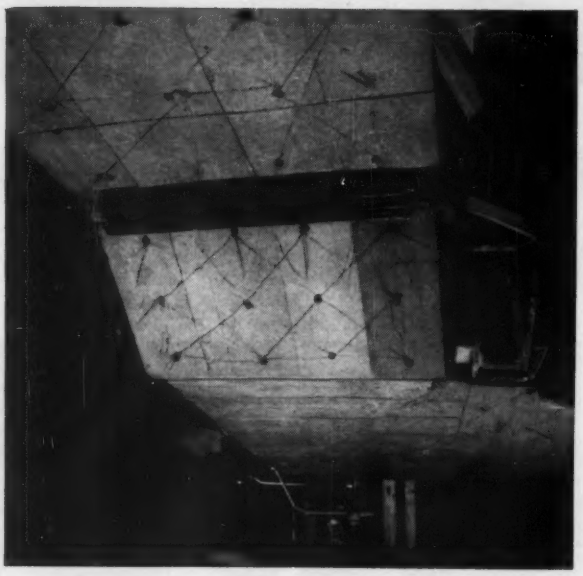
"We're Really Able to Pile Up Hours and still get good engine life using Cities Service C-300 Lube Oil," says Supt. Leslie. "I've never had the head off the Enterprise since it was installed in 1953. Compression, fire pressure, and fuel economy are excellent."

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

EAGLE-PICHER
PV SUPERTEMP
BLOCK INSULATION

with the NEW *"Precision-Finish"*



A TRUE-CUT BLOCK! Eagle-Picher's new "precision-finish" is one of the most important insulation developments in years. Here's a highly efficient, all-purpose insulating block that is practically dustless.

GREAT STRUCTURAL STRENGTH! Eagle-Picher PV Supertemp Block meets your specific demands for long-lasting insulating block able to withstand a wide hot surface temperature range up to 1900 F. PV Block effectively resists steam and other moisture, does not disintegrate or lose thermal efficiency under heavy-duty service.

EASILY INSTALLED! Lightweight PV Supertemp Block is easy to handle, requires only minimum reinforcing. It is easily cut to fit irregular areas—and no special tools are needed.

WRITE FOR FREE SAMPLE TODAY!

Compare Eagle-Picher PV Supertemp Block with other insulating blocks. You'll appreciate the improved temperature control that pays off in greater fuel savings. You'll sell yourself on the new "precision-finish"!

Since 1843

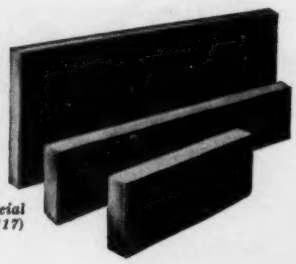
EAGLE EP PICHER

THE EAGLE-PICHER COMPANY

Producing a complete line of industrial insulations

Cincinnati 1, Ohio

(Member of Industrial Mineral Fiber Institute)



(Conforms to Commercial Standard CS 117)

Now a new standard of safety in low-voltage switchgear

Test position with doors closed

This exclusive I-T-E low voltage switchgear feature establishes a new standard of safety in testing circuit breakers. It offers the additional advantages of reduced handling; less maintenance; convenient "tagging out"; better dust protection; easier circuit identification. And all are yours at no increase in cost in the compact, modern design of I-T-E low-voltage switchgear.

For complete information, contact your nearest I-T-E sales office. Or write for Bulletin 6004B. I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY
Switchgear Division

NOW

BROWN BOVERI GAS TURBINES

NON-REGENERATIVE CYCLE with 25% FIELD-TESTED EFFICIENCY

A 25,000 kW Brown Boveri Gas Turbine installed for Societa Selt Valdarno at Livorno, Italy, for peak load service using Bunker C oil. Proven tested efficiency of 25%. Non-regenerative cycle. Operating temperature on the gas side, 1200°F. insuring long life and low maintenance. Another identical unit goes into operation in May 1956.

WITH a proven-in-actual-operation efficiency of 25%, Brown Boveri Non-Regenerative Cycle Gas Turbines are setting new standards for performance and economy. This operating experience with large turbines — even those fired with low-grade gas or oil — can be found only in Brown Boveri Gas Turbines.

In first costs, these turbines show marked savings. They cost substantially less than comparable conventional steam turbine plants.

If you are concerned with large output gas turbines, it will pay you to investigate Brown Boveri equipment.

Other Recent Orders for identical 25,000 kW Brown Boveri Non-Regenerative Cycle GAS TURBINES

- **Societa Romana di Electtricita for Roma 1 (Italy) Power Station**
- **Gullspong Munksfors Kraft AB Oerebro for Otterbacken Power Station**
- **City of Edmonton, Canada, Power Plant, 2 units**
- **City of Vancouver, Canada, Power Plant, 3 units**
- **City of Jourcan, Canada, Power Plant, 1 unit**

BROWN BOVERI

BROWN BOVERI CORPORATION

19 RECTOR STREET • NEW YORK 6, N. Y.

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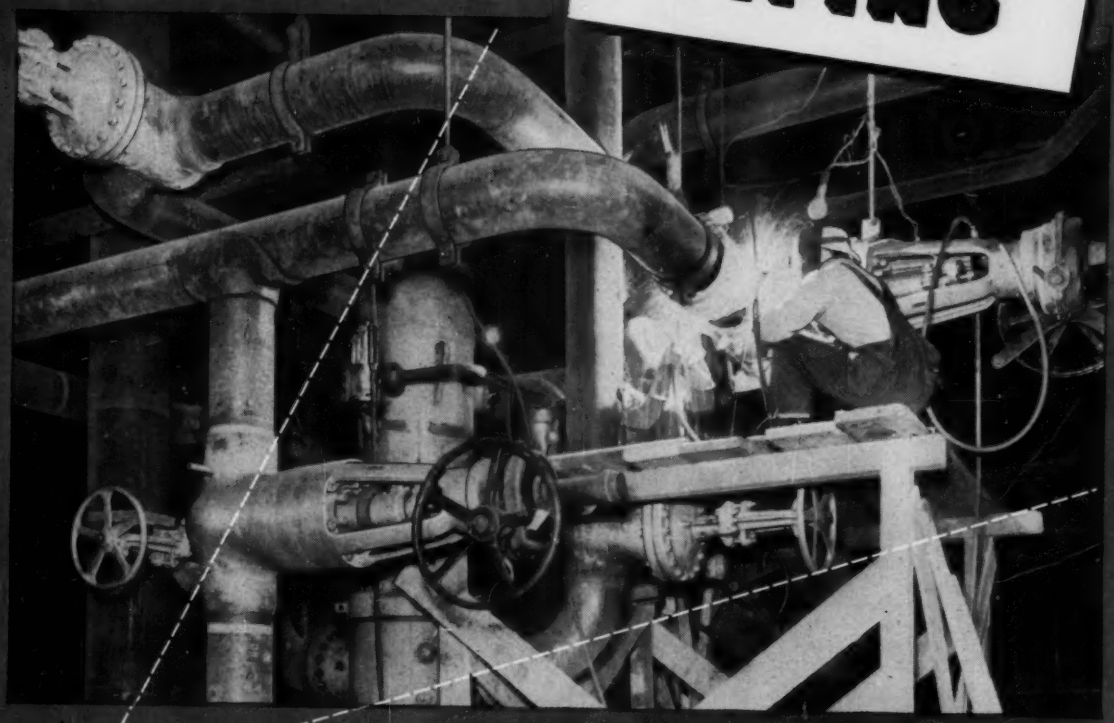
THERE IS MUCH MORE TO MIDWEST PIPING



THAN MEETS THE EYE

Here you see carefully qualified Midwest welders erecting the boiler feed piping in a new public utility steam-electric generating station. What you don't see are the many other highly skilled men who contribute to the high quality of Midwest Piping.

First, there are the expert piping engineers who prepare the job for fabrication. They simplify the field work and make sure the difficult operations are done in the shop. And they often make suggestions that improve the design and reduce the cost of the piping.

Then there is the experienced shop organization (working with the most modern equipment) that delivers to the field subassemblies which are accurate in dimension, correct in alignment, thoroughly cleaned, heat treated when necessary, carefully inspected and tested . . . ready for erection at lowest cost. Both the shop and field supervisory personnel have come up through the ranks and know every phase of the operations . . . how to assure the customer the most for his money when he buys Midwest Piping.

MIDWEST PIPING COMPANY, INC.

Main Office, 1450 South Second St., St. Louis 4, Mo.

Plants: St. Louis, Clifton, N.J. and Los Angeles

Sales Offices:

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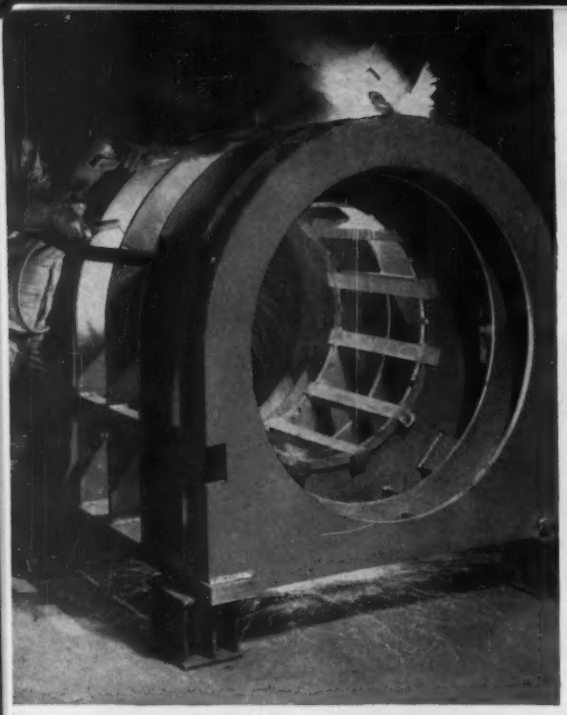
Boston 27—426 First St. • Los Angeles 33—520 Anderson St.
Houston 2—1213 Capitol Avenue • Tulsa 3—224 Wright Bldg.
Cleveland 14—616 St. Clair Ave. • Miami 34—2103 Le Jeune Rd.

MIDWEST **PIPING FABRICATION and CONSTRUCTION**

OFFERS YOU MANY BENEFITS



The a b c's of NEWEST large 2-pole Induction Motor Construction

Here's a picture sequence showing a big E-M 2-pole boiler feedwater pump motor* in construction. Step by step you can observe the modern engineering and meticulous care given to every detail by E-M craftsmen. The little rhymes will call your attention to the key points in each picture.

As you know, requirements for big motors are exacting . . . the duty severe. Here you can see how E-M builds in extra quality to give you top performance, reliability, smooth operation and economy. The E-M sales engineer in your area has many more interesting facts on these big E-M Motors he'll be glad to tell you.

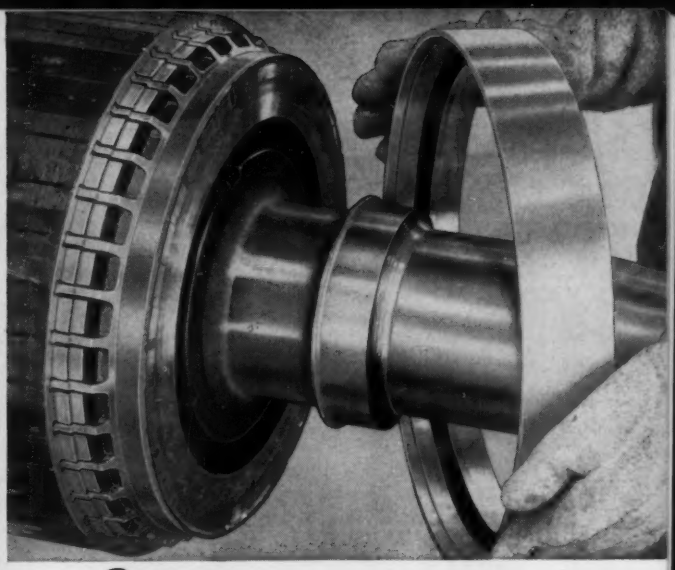
*E-M 2-pole Heavy-Duty Squirrel-Cage Induction Motor (1500 hp and larger)

a A's for All-welded, this reinforced frame;
It's made extra rugged to stay in the game.
All welds are continuous, tested for strength—
There'll be no distortion in width or in length.

b Burrs are removed before laminations are stacked,
For a low-loss core that is true and compact.
The baked-on enamel coating of each lamination
Provides high dielectric strength and corrosion elimination.

c C is for Coils, with vacuum impregnation
To provide the best in protective insulation.
They're form-pressed to slot size to fit on the dot . . .
Each coil is surge-tested before reaching its slot.

d D is for Diligence in anchoring the winding . . ,
Each coil side is lashed to provide an "arch" binding.
These tight E-M coil ends won't be twisting or parting
In any hard demand of full-voltage starting!

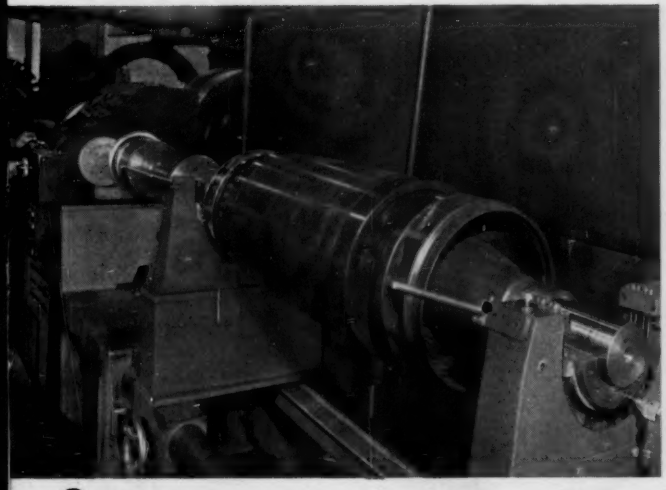


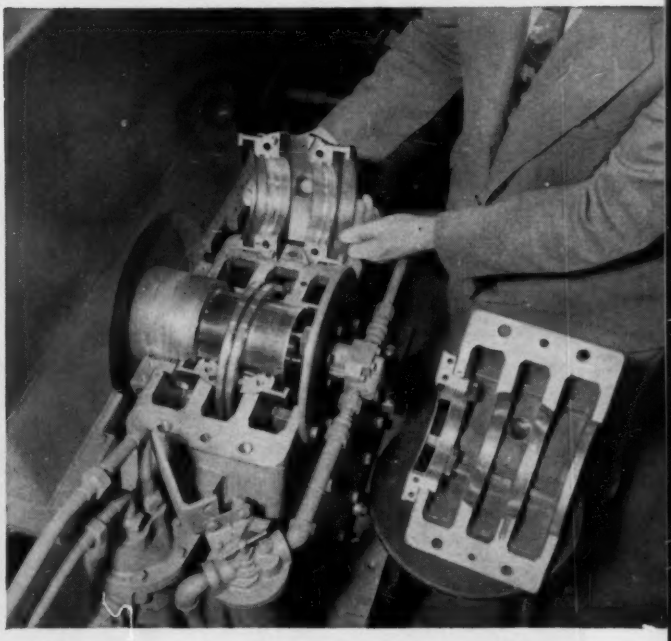
f

F is for Freedom from centrifugal force distortion,
In end-ring structure and retaining ring portion.
The cage bars fit rotor slots snug and tight—
Joints are silver-brazed; they stay just right.

e

Extra protection for the E-M wound stator . . .
It's full-flooded with varnish—a real first-rater!
It's baked and re-flooded and re-baked at a pace
That seals the coil surface in every place.



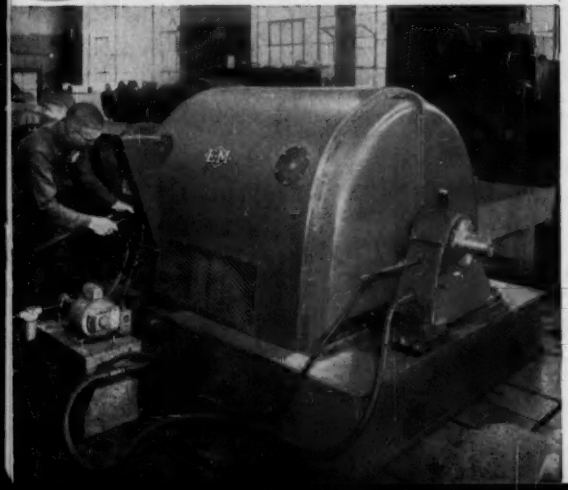


g

G is for the Gisholt electronic machine
That checks rotor balance with an eye true and keen.
Again in the stator we check balance of the rotor
Because it's so important to a smooth-running motor.

h

High finish on journals, superfinish is the rule.
The bearings are well-sealed . . . they'll run long and cool.
The sleeves are Kolene-processed to last and last.
Double oil rings start lubrication safe and fast.



i

Inspection is thorough, when we've done all the rest,
For each E-M machine stands a rigorous test.
When it's installed in your plant, you know it can take it . . .
It's bound to be rugged, for it had experts to make it!

Like to know more about this 2-pole Motor beauty
For feedwater pumps or other hard-driving duty?
Just call your nearest E-M sales engineer now
For facts, data and application know-how.
Or write to the factory—there's much you can glean
From E-M's new brochure Number 214.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

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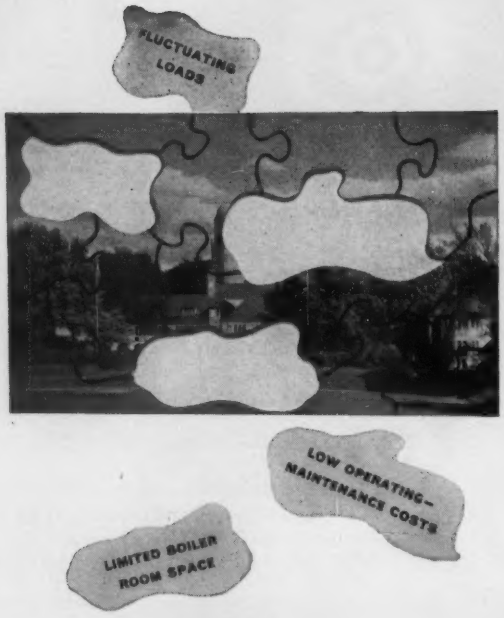
E-M

Specialists in making motors do exactly what you want them to



HOW A JIGSAW HEATING PUZZLE WAS SOLVED

KEWANEE reserve plus rated boilers

MET SCHOOL HEATING NEEDS

A jigsaw puzzle heating problem . . . that's what it looked like at the Cranbrook School for Boys, Bloomfield Hills, Michigan, since the heating needs were so varied. But every puzzle piece fell into place when Kewanee Reserve Plus Rated Boilers were installed, because all heating needs were solved. Here's the way it worked:

Problem 1: Limited boiler room.

Solution: Two compact Kewanee Scotch Type Boilers with 50% reserve power guaranteed adequate heat under all conditions.

Problem 2: Fluctuating loads—boiler turned off nightly, turned on by stages in the morning.

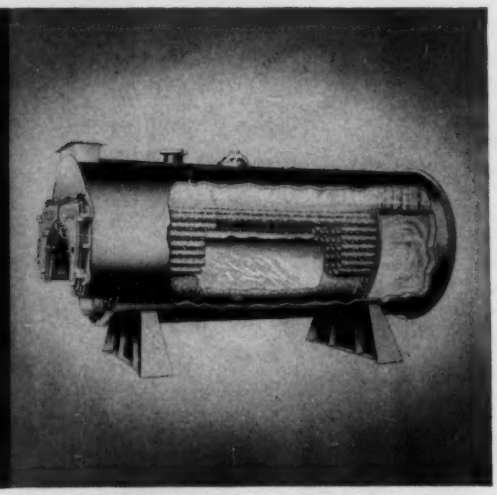
Solution: Kewanee Boilers had sufficient reserve to assure a fast, dry steam when needed to give quick heat.

Problem 3: Low operating—maintenance costs.

Solution: Since Kewanee Reserve Plus Rated Boilers certify 50% extra power built in, they operate at "cruising speed." Result—less fuel used, less wear on boiler, greater efficiency delivered.

Kewanee Reserve Plus means boilers are rated on nominal capacity, with adequate power to take care of present needs, emergencies and future expansion. Boilers rated on maximum capacity are inadequate for today's fast growing school needs. Next time select Kewanee Boilers.

Cranbrook School for Boys, Bloomfield Hills, Michigan
Heating Contractor: Laing Plumbing & Heating Company, Pontiac, Michigan
Engineer: Snyder & McLean, Detroit, Michigan

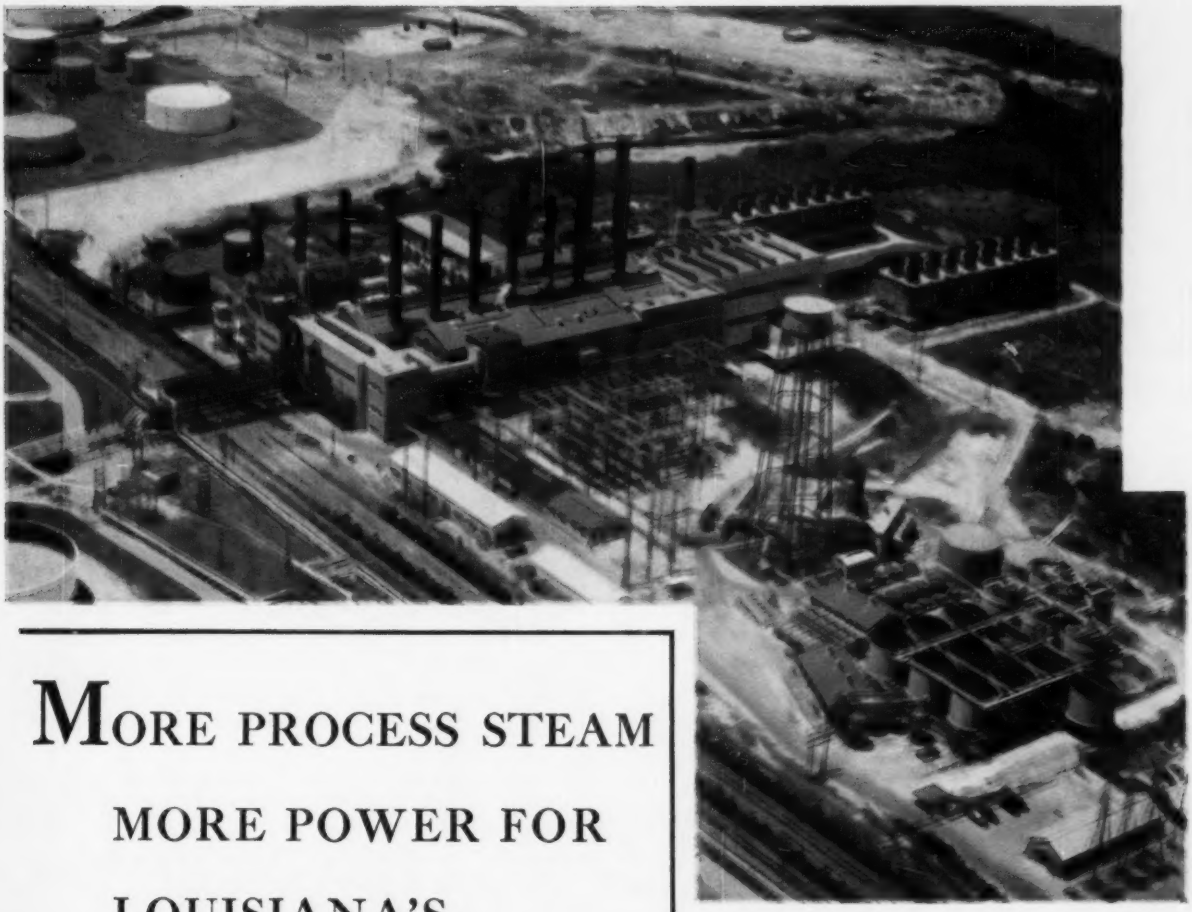


Kewanee LM-800 Series for 15 lbs. steam or 30 lbs. water installed in the Cranbrook School for Boys.

KEWANEE BOILER DIVISION
of American-Standard
101 FRANKLIN STREET, KEWANEE, ILLINOIS

KEWANEE BOILERS

You can depend on Kewanee engineering



MORE PROCESS STEAM MORE POWER FOR LOUISIANA'S INDUSTRIES

Louisiana Station, situated north of Baton Rouge, was the first large plant designed to utilize oil refinery residues for as much as one-third of its total fuel requirements.

Louisiana Station of Gulf States Utilities Company was designed and built by Stone & Webster Engineering Corporation in 1930. With an initial capacity of 1,500,000 pounds of steam per hour and 45,000 kilowatts, it was one of the first utility plants to generate electric power as a by-product of the large scale supply of process steam for industry.

To supply the additional requirements of the oil refinery which was its original customer, as well as those of new industries attracted to the area which utilized both process steam and electric power, Gulf States through the years has engaged the Corporation to design and build new units. The most recent addition, just completed, brings the total capacity of the plant to about 6,750,000 pounds of steam per hour and 406,000 kilowatts.

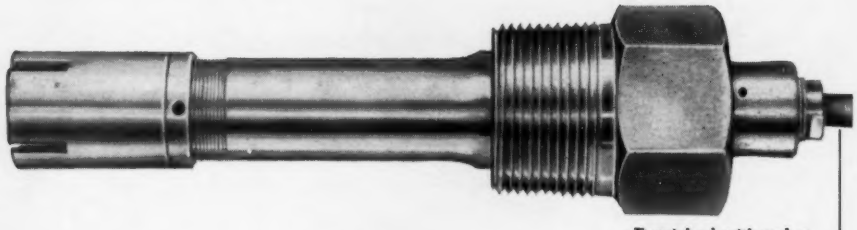
If you have a problem of design or construction, our broad experience in these and related fields may help you solve it. Write or call us for complete information on our services.

STONE & WEBSTER ENGINEERING CORPORATION

AFFILIATED WITH E. B. BADGER & SONS LIMITED (LONDON)

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

NEW! TODAY'S MOST ADVANCED CONDUCTIVITY CELL



Furnished with valve for removing under pressure.

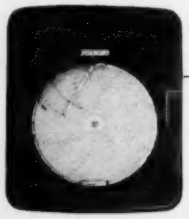
Exclusive New Carbon Electrode Design
No Platinizing Required
Practically Maintenance-Free
Leakproof—Even at 125 psig

Here's the biggest advance in conductivity cell design in years! Foxboro Carbon Electrode Conductivity Cells now virtually eliminate cell and electrode maintenance in conductivity measurements up to 10,000 micromhos!**

Foxboro Carbon Electrodes provide all the desirable surface characteristics of platinized metallic electrodes, yet require no platinization or other special coating. Cleaning, if necessary, involves simply a light brushing to keep them operating at peak efficiency. They're cased in stainless steel or brass (not glass) — you don't have to "handle with care". The electrodes are solidly anchored . . . cell constant can't change during cleaning or operation. What's more, you're sure of leak proof operation. Special "O"-ring seals and the foolproof Foxboro cable-seal protect the cell at pressures up to 125 psig — even when completely immersed.

These rugged cells, with Foxboro Dynalog* measuring instruments, form completely integrated systems for measurement or control . . . ideal for any industrial applications. For full details, write for Bulletin 13-19. **The Foxboro Company, 684 Neponset Ave., Foxboro, Mass., U.S.A.**

**Available with constants of .01, 0.1, and 1.0. For measurements above 10,000 micromhos, specify Foxboro Platinum Electrode Conductivity Cells.



DYNALOG*

Direct-Reading Conductivity Measuring Instruments

Provide unequalled accuracy, sensitivity, and speed of response for conductivity measurements and control. Dynalog's step-less capacity balancing system eliminates slidewire maintenance. No standardizing necessary. 1000-cycle A.C. voltage to the conductivity cell keeps polarization effects at a minimum. Multi-Record Dynalog Instruments available for recording up to 6 different conductivity values on a single chart.

*Reg. U. S. Pat. Off.

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CARBON ELECTRODE CONDUCTIVITY CELLS

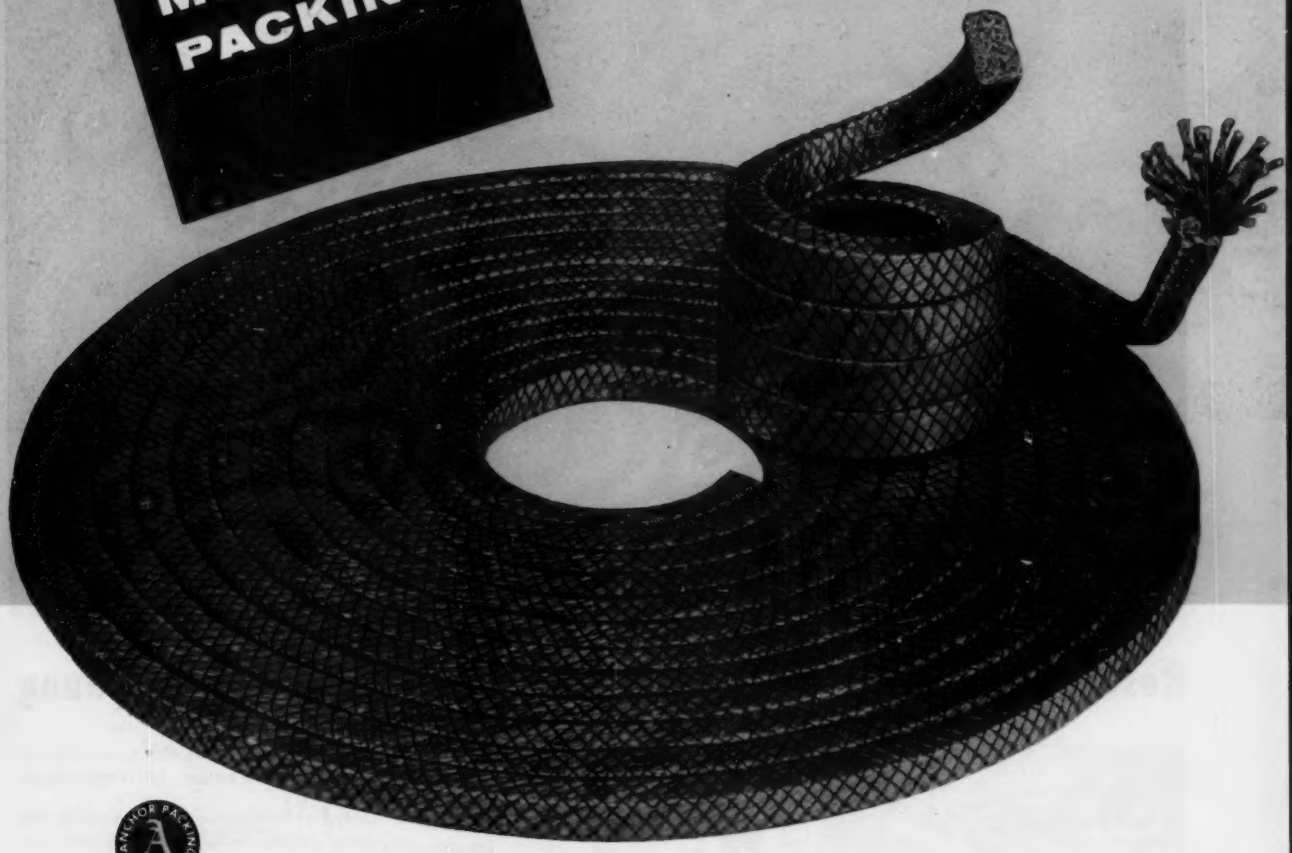
ANCHOR offers you this IMPROVED METALLIC PACKING!

Resilient... Flexible...

Anchor 851-T.T., available in ring, spiral or coil form, readily adjusts itself when pressure is applied to the gland being packed. It is today widely used on temperatures as high as 500°F. and may be used in any service where a Babbitt metal is suitable.

Anchor 851-T.T. is adapted for high speeds of turbines and centrifugal pumps. Thus, properly applied on rods, shafts or plungers that are not scored or shouldered and are running true, it is the most economical packing to use due to low friction which prolongs its life.

For specific sizes, applications and features, write us today.



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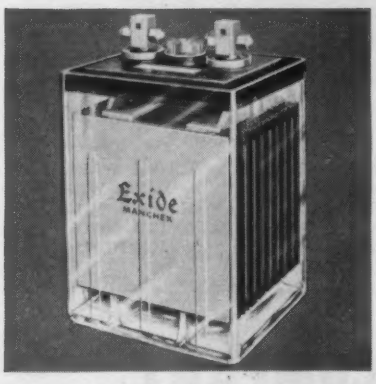
FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

EXIDE-MANCHEX BATTERIES

Emergency power source for generating stations and substations

Reserve lead supply in spiral buttons keeps battery young



SWITCHGEAR BATTERY. Exide-Manchex Batteries are available in a wide range of capacities from 8 to 960 ampere hours, with improved high rate discharge characteristics. Compact construction saves space and weight. Flat cover easy to clean. Write for Bulletin No. 4852.

Long after most other types of batteries turn up their toes and die, Exide-Manchex Batteries used in floating service applications are still going strong. And they keep on going strong for years and years.

The reason can be found in their unique construction. Exide engineers have cut through the center of an Exide-Manchex positive plate and photographed the results shown above. Under the outer layer of active material on the spiral buttons you can see a shiny core of reserve lead. During the life of the battery, this lead turns slowly to active material as it is needed. Yet the inactive metal grid never, never weakens; always retains its shape; holds the buttons firmly in place. Hence battery life is prolonged.

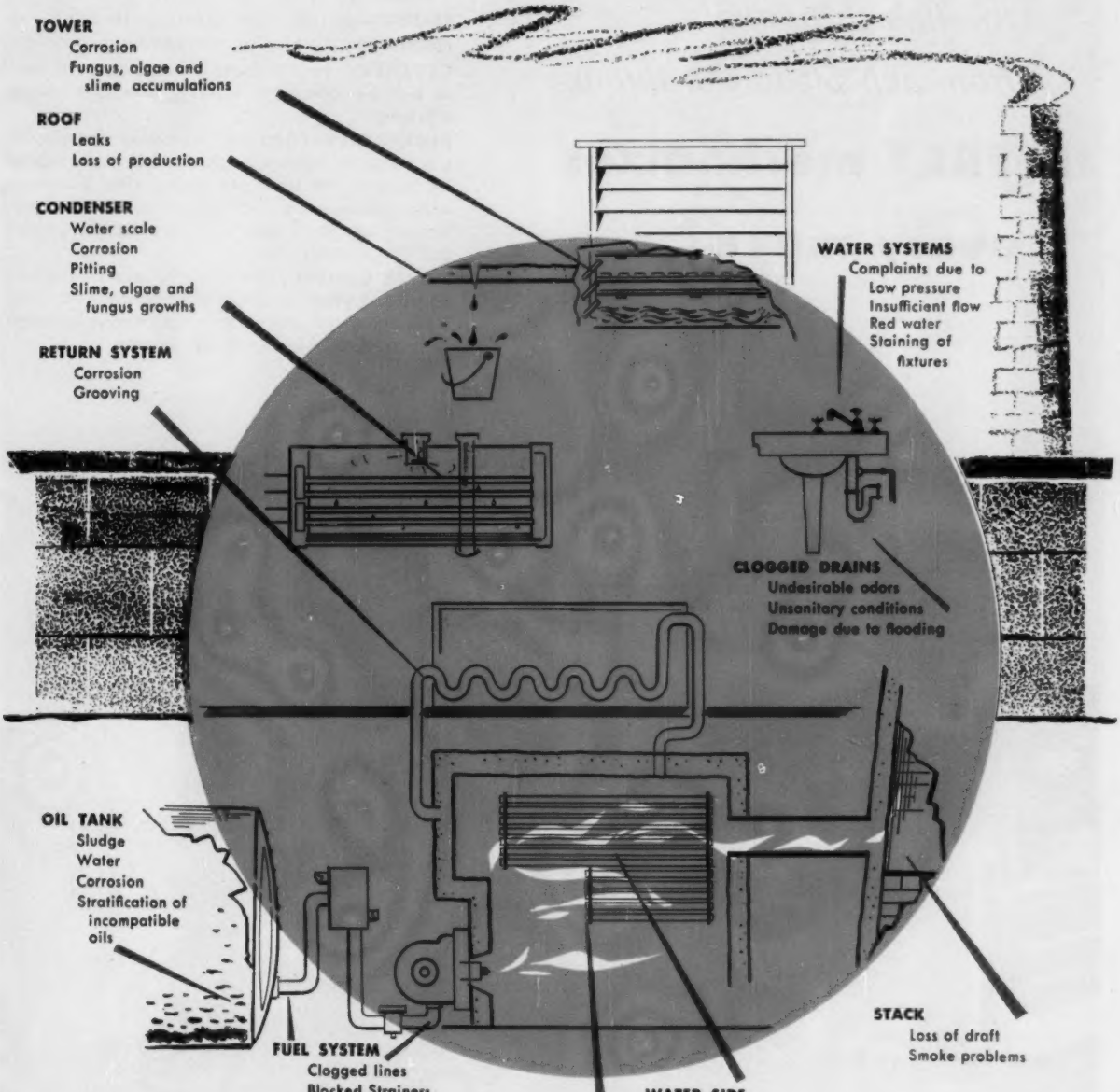
Only Exide-Manchex Batteries offer this extra assurance of long battery life. When you order batteries for floating service applications—whether with new equipment or for replacement—be sure to specify Exide-Manchex. For information, call the Exide sales office near you. Exide Industrial Division, The Electric Storage Battery Company, Philadelphia 2, Pa.

Exide®

ALKEN-MURRAY CORPORATION

ESTABLISHED 1934

First to: DIAGNOSE, PRESCRIBE AND GUARANTEE TO CORRECT ALMOST ANY PROBLEM DUE TO ANY TYPE FUEL OR WATER



LET US HELP YOU WITH YOUR PROBLEM

WRITE TO ALKEN-MURRAY CORPORATION, DEPT. P-1
131 EAST 23RD STREET • NEW YORK 10, N. Y.

from track hopper
to silos to bunkers...
from ash pit to the dump,

JEFFREY mechanizes every move!

For many years, Jeffrey coal and ash handling equipment has been safeguarding service in many of the country's power plants. And showing a remarkably low cost-per-ton of coal handled. Jeffrey makes equipment for every type and size of plant.

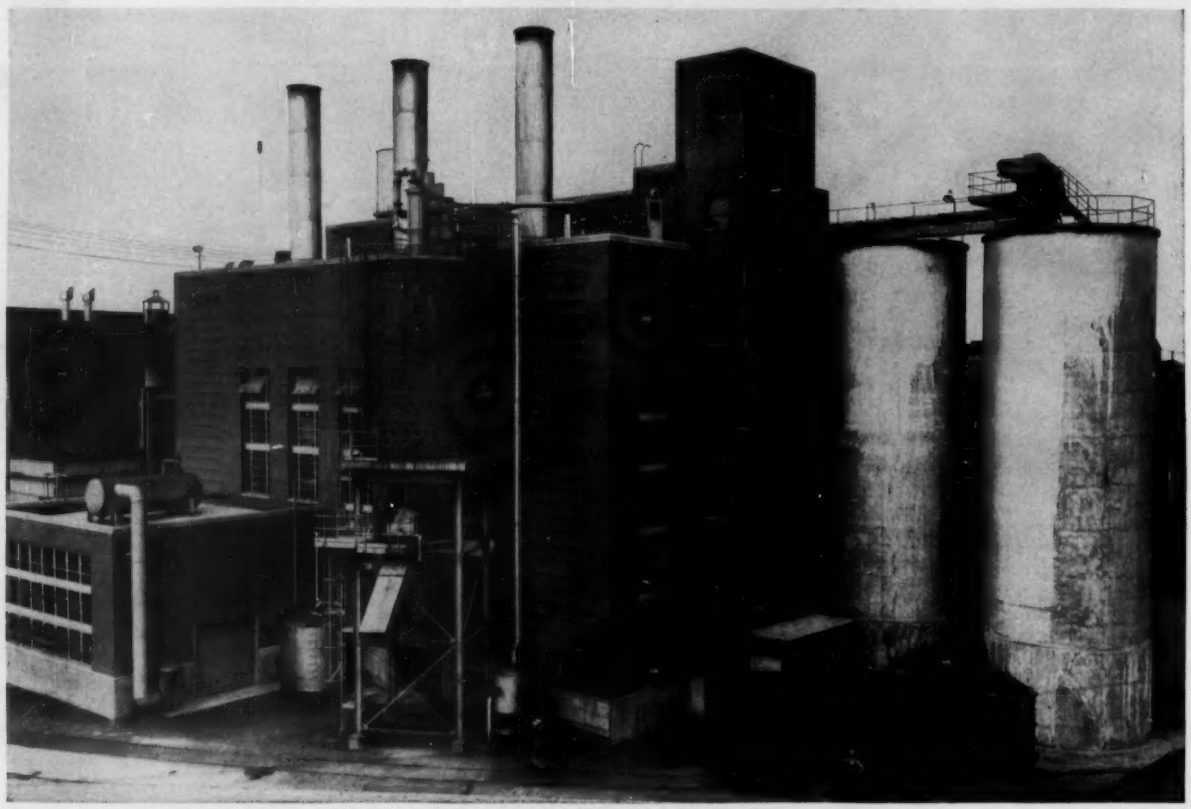
TRACK HOPPERS—in many shapes and sizes; 5 tons to 30.

FEEDERS—spiral, plate, electric vibrating and apron feeders; a type to meet any local condition.

CRUSHERS—reduce lump coal to uniform sizes in a single operation, assuring maximum stoker efficiency.

BUCKET ELEVATORS—for elevating and distributing coal; in various heights and in capacities of 25 tons to 40 tons per hour. Also V-bucket elevator-conveyors and pivoted bucket carriers. Scraper and drag chain conveyors for inclined and horizontal runs.

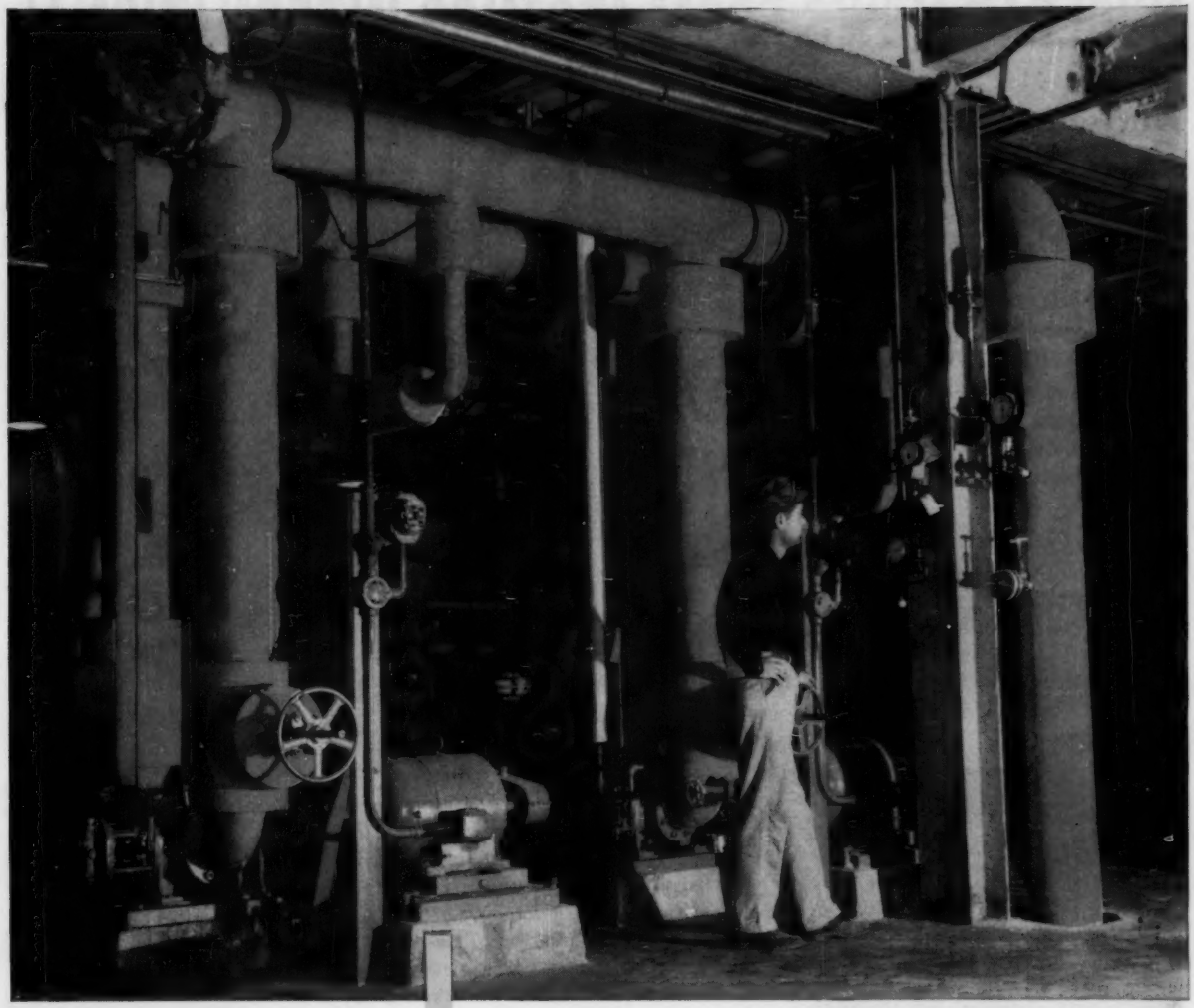
SPIRAL CONVEYORS—ideal for use in limited space and where demands are moderate. Coal can be discharged at any point through valves in trough bottom. Available in various lengths.



Jeffrey engineers will assist you in selecting the most efficient and economical Jeffrey coal and ash handling equipment to meet your requirements. Literature is available on each of these product groups. The Jeffrey Manufacturing Company, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT • TRANSMISSION MACHINERY • CONTRACT MANUFACTURING



Specify GUSTIN gb BACON SNAP*ON *for good and fitting reasons*

Plant piping takes on this trim, tailored look — and in record time — when you insulate with G-B Snap*On, the one-piece molded pipe insulation of fine glass fibers. From ¾" through 33" IPS and in 3' and 6' sections depending on pipe size. With just a pocket knife and a stock of Snap*On in nesting sizes, *anyone* can make easy work of the once-tedious job of insulating bends, valves and other fittings.

To fully understand why this material saves so much time and money on fittings and straight runs you need only handle a 6-foot section of Snap*On. It's flexible, yet resilient. It's feather-light, yet tough. It's almost impossible to damage, yet easy to cut with a knife. And to these obvious advantages, you can add such unseen benefits as *permanence* and the *highest thermal efficiency of any pipe insulation on the market.*

Next time you have hot or cold piping to insulate, call your nearby distributor, listed in the Yellow Pages under "G-B Insulations." In the meantime, write today for our new 8-page brochure with full details on "the first all-new pipe insulation in 60 years."

GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON

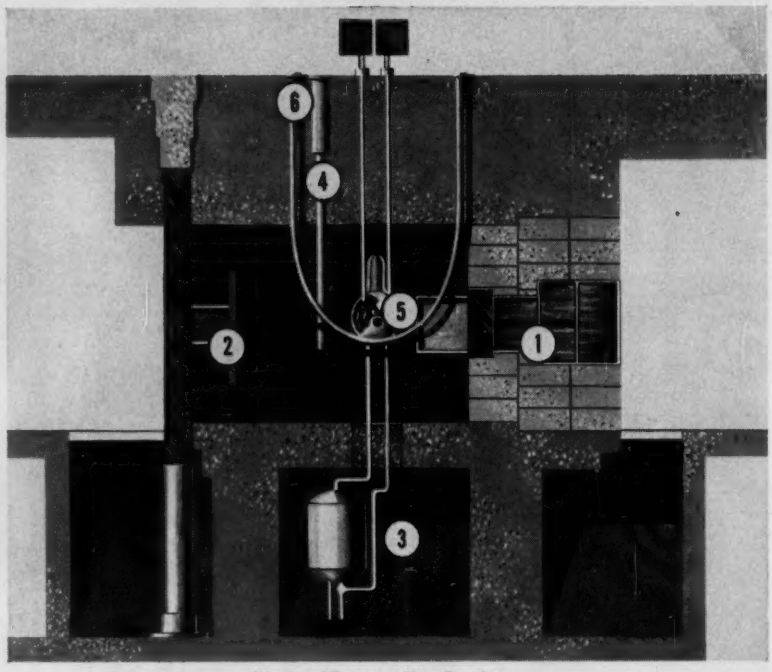
Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Railroad gaskets and supplies.

248 W. 10th ST., KANSAS CITY, MO.

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

Nuclear Reactor for Cancer and Other Medical Research

This new reactor utilizes the proven homogeneous solution design based on the SUPO unit at Los Alamos—modified and adapted to the special needs of cancer and other medical research and therapy. To be built by ATOMICS INTERNATIONAL for a prominent southern California university Medical Center, the reactor will provide a variety of radiological facilities—primarily high purity neutron and gamma beams with controlled exposure times in each. The thermal neutron flux at the central exposure tube is 1.7×10^{12} n/cm²-sec. at a power of 50 Kw.



Medical Reactor Test Facilities

1. Gamma and Fast Neutron Facility—Gamma intensities of 1.3 reb/min/Kw and fast neutron intensities of 4 reb/min/Kw are available.
2. Thermal Neutron Facility—Provides neutron flux of 3.8×10^7 n/cm²-sec. per kilowatt.
3. Gamma Radiation Area—Activity of the fission gases provides a radiation source in the gas handling equipment room.
4. Multiple Specimen Irradiation Tube—One or more in the reflector. Each accommodates 16 samples.
5. Central Exposure Tube—A 1-inch internal diameter tube through the center of the core permits access to maximum neutron flux.
6. Pneumatic Tubes—Tangential to core. Also (not shown) are Beam Tubes—Radial to core, or through reflector tangential to the core.

Gas handling system assembly for nuclear research reactor. This component, developed by Atomics International, contains facilities for circulating the reactor atmosphere, recombining the radiolytic gases, condensing the water vapor and returning water to the reactor core, in a closed cycle operation. Additionally, the tank at top which contains fission product gases, provides an intense source of neutron-free gamma radiation.

One Configuration of the thermal neutron facility provides a neutron flux of 3.8×10^7 n/cm²-sec/Kw with a gamma ray intensity of only 0.1 reb/min./Kw (reb—roentgen equivalent biological). The fuel is Uranium enriched in the U^{235} isotope in the form of UO_2SO_4 dissolved in light water. This fuel-moderator solution, cooled by chilled recirculated water, is contained in a stainless steel core tank surrounded by a graphite reflector and dense concrete shield. Radiolytic and fission gases produced in operation are handled in a closed-cycle, water recombination and return system, which eliminates any discharge of radioactive core effluents and permits the re-utilization of materials.

Atomics International is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. If you are interested in any phase of our activities, ATOMICS INTERNATIONAL is staffed and equipped to help you. Please write: Applications Engineering Service, Dept. PW-N1, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

POSITIVE PROTECTION FOR YOUR SYSTEMS!

STRONG STRAINERS

trap dirt, scale, sludge, sediment

Stainless screens . . . perforated or woven wire . . . rust and corrosion proof . . . standard interchangeable sizes . . . tap for pipe plug or valve

Rugged bodies . . . extra tough semi-steel, bronze, cast steel, block steel or chrome moly construction withstands rough use . . . threaded, flanged or socket weld connections

Attractive range of sizes . . . from ¼" to 6" strainers with .027", 1/16", ⅛" perforations; 60 or 100 mesh screens

Dirt-free steam, water, air, oil or gas lines are assured when Strong Strainers are on the job. They come in "Y" or angle types. Strong Strainers are available for every need, **built right, priced right for your requirement.**

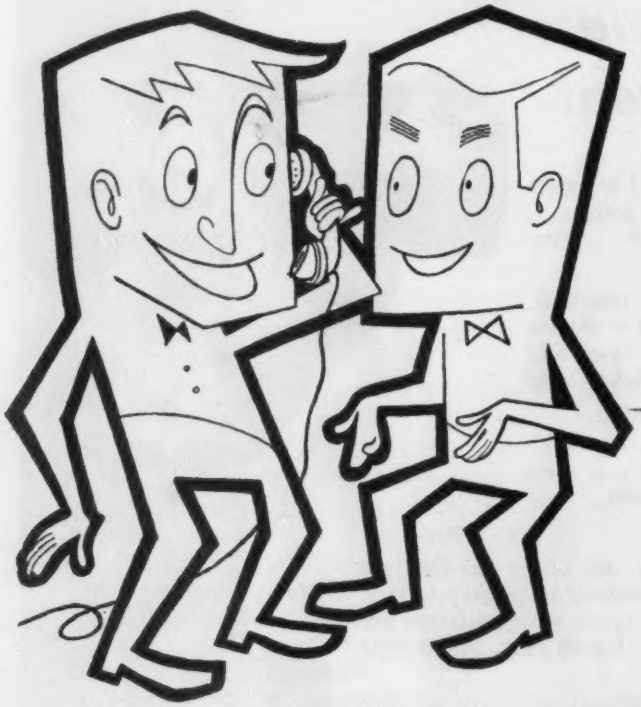
For complete specifications and prices see your **Strong Distributor** or write . . .

STRONG, CARLISLE & HAMMOND COMPANY
1392 WEST 3rd STREET • CLEVELAND 13, OHIO

air traps • steam traps • reducing valves • vacuum or pumping traps
continuous blowdown valves • separators • engine stops • F and T traps

How come you can get all the coal you want? Our deliveries have been slow!

That's because we buy all our coal from mines on the Chesapeake & Ohio. C & O has more coal cars than any other railroad and keeps close to 99% of them in good order. This ready car supply means an uninterrupted flow of coal to consumers.



How about the coal? Is that as good as the service?

C & O territory has always been known for the superior quality coal it produces. And the C & O fuel service engineer is always ready to help us find exactly the right coal for our particular needs.

P.S.

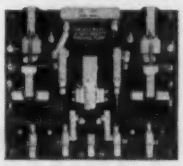
There's a lot more to buying coal than the cost per million BTU. Why not contact coal producers on the C & O to solve your particular fuel requirements, or write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Co., Terminal Tower, Cleveland 1, Ohio, for the assistance of a C & O fuel service engineer.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

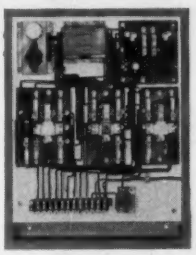
ASCO *the one source for every* EMERGENCY ELECTRICAL CONTROL

EMERGENCY SIDE



DEMAND START PANEL

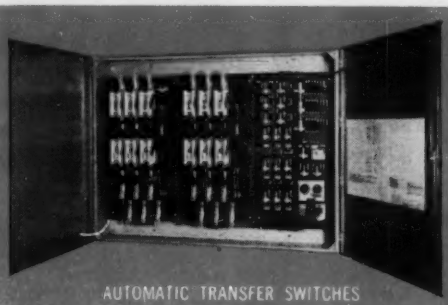
Designed to start engine automatically when any load is applied and to automatically stop engine when all load is removed. Has built-in device that automatically holds off load until voltage and frequency are at proper ratings.



ENGINE STARTING PANEL

Initiates cranking of electrical plant upon normal source failure. Panel relays operate a "pump closing" solenoid to stop the plant upon restoration of normal voltage. Available for both diesel and gasoline engines, designed to your specifications.

The Automatic Switch Company designs and manufactures *all* electromagnetic control equipment for standby emergency power installations. Dependable ASCO equipment serves hospitals, hotels, television studios, mines, railroad and subway generating stations — wherever continuity of light and power is a necessity. And ASCO equipment is of particular importance in microwave installations and for restaurants and toll booths on new super highways.



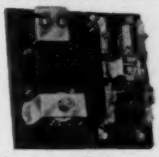
AUTOMATIC TRANSFER SWITCHES

Available for all classes of load up to 750 volts AC-DC, these switches transfer connected load to emergency power sources when normal power fails or is substantially reduced. Once the normal source is again at proper voltage and frequency the load is automatically returned. Designed in sizes from 10 to 1000 amperes, ASCO Automatic Transfer Switches are double throw, inherently interlocked types.

NORMAL SIDE

TIME DELAY RELAYS

Supplied as "built-in" components of automatic transfer switches, these relays cause the switch to ignore harmless power dips and outages, protecting the generator from false starts. They permit transfer of load to emergency only if outage is sustained. Also available as a unit.



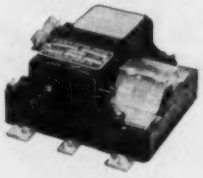
CLOSE DIFFERENTIAL RELAYS

These relays provide "adequate-voltage" power (overvoltage and undervoltage protection). They cause the transfer switch to transfer the load to emergency on a 5% differential in power supply voltage or less if required. Also available for close differential frequency control.

BATTERY CHARGER

Operating from the normal supply, this charger keeps electric plant starting batteries charged, ready for engine starting. Can supply trickle or high rate charge.

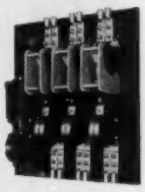
LOAD SIDE



REMOTE CONTROL SWITCHES

BULLETIN 920

Remote control switches are used to disconnect distribution circuits. U.L. approved to 600 volts, AC, 250 volts DC, ASCO has a complete line of RC's from 10 to 1000 amperes. This one is rated for loads up to 200 amperes.



BULLETIN 911

For higher amperage, this remote control switch may be used for all classes of load, 600 volts AC, 250 volts DC maximum. It is available in 2-pole 3-pole and 4-pole types and is rated up to 1000 amperes.

To learn more about ASCO equipment: See Section I for data on ASCO Electromagnetic Controls — relays, contactors, solenoids, complete control panels. See Section J for information on the extensive line of ASCO Solenoid Valves.

WRITE US FOR MORE DETAILED INFORMATION ON ASCO ELECTROMAGNETIC CONTROL EQUIPMENT FOR EMERGENCY STANDBY POWER.

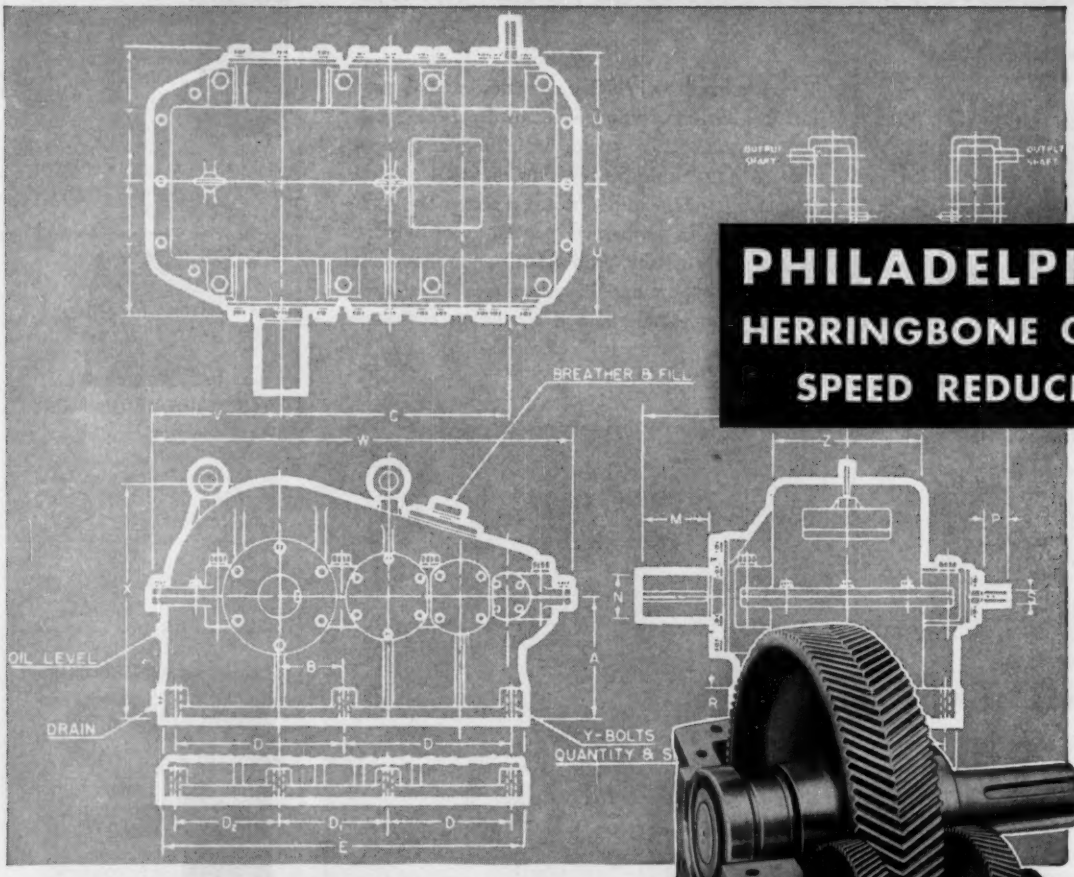
ASCO®

Automatic Transfer Switches
Electromagnetic Controls
Solenoid Valves

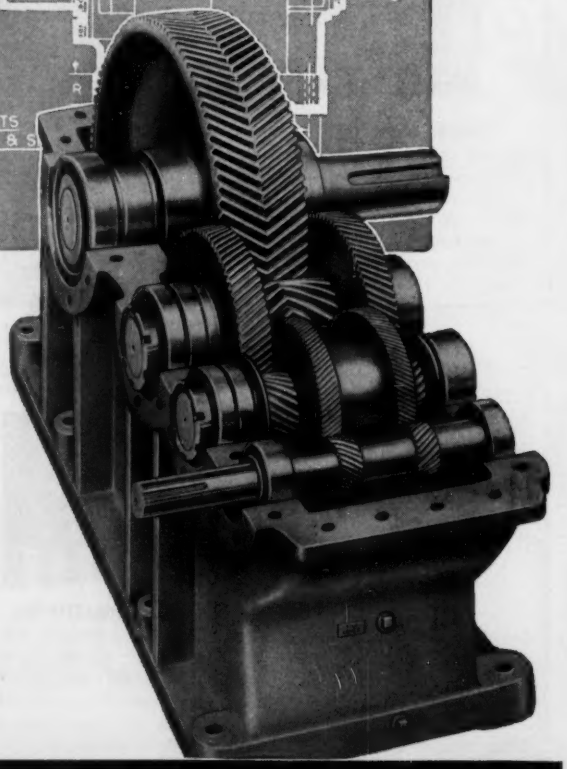
Automatic Switch Co.

392B Lakeside Avenue, Orange, New Jersey

Here's the Reducer with a BACKBONE . . . . and a BACKGROUND



PHILADELPHIA HERRINGBONE GEAR SPEED REDUCER



Yes, Philadelphia Herringbone Reducers can truthfully be said to be *Reducers with a "backbone" and a "background,"* because we have not only been making industrial speed reducers since their inception—but we were one of the pioneers in applying the Sykes continuous tooth type gear to speed reducers.

If you have a problem involving high horsepower speed reduction with heavy shock loads, Philadelphia Herringbone Reducers are the answer. These quality-built units are available in Single, Double and Triple Reduction Types, offering a wide selection of capacities and reduction ratios. The continuous tooth type herringbone gears assure evenly distributed pressure over each tooth from the top to the working depth line—which means exceptionally long life, minimum vibration, quiet operation and maximum transmission of power . . . Thousands of Philadelphia Herringbone Reducers are in daily use, in most every line of industry. Be convinced, send for Catalog H-55.

PHILADELPHIA GEAR WORKS, INC.

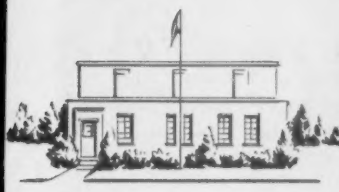
ERIE AVE. & G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
BALTIMORE • CLEVELAND
Virginia Gear & Machine Corp. • Lynchburg, Va.

Industrial Gears & Speed Reducers

LimiTorque Valve Controls

Established 1892

Melvin Nissen (left) plant superintendent Graettinger, Iowa, and Standard Oil lubrication specialist R. R. Spargo inspect maintenance records. Assisting customers with lubrication problems is something for which Bob Spargo is well qualified. He is a mechanical engineer with a degree from Iowa State College and a graduate of the Standard Oil Sales Engineering School. Bob has been providing lubrication technical assistance to Standard customers for nearly nine years. Customers find his experience and training pay off *for them.*



How STANDARD D&G Oil helped lick five problems in one plant

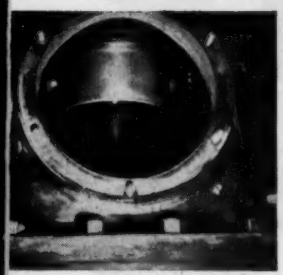
Excessive deposits, excessive maintenance, high oil consumption, were among problems solved by change-over to STANDARD D&G Oil at Graettinger, Iowa, Municipal Light Plant

Three years ago the Graettinger Municipal Light Plant began using STANDARD D&G Oil. Prior to this change-over, good engine performance was hampered by:

1. **Excessive carbon deposits**
2. **Excessive port carbon**
3. **Stack fires**
4. **Ring sticking**
5. **High oil consumption**

The plant averages 4.3 million HP hours of operation annually. Before changing to STANDARD D&G Oil, ports had to be cleaned several times a year. Now, with STANDARD D&G Oil in the engines, ports aren't touched between annual overhauls. Ring sticking and piston and cylinder deposits are virtually eliminated. All of this has been accomplished while continuing the use of low cetane, low gravity fuel.

Good management, careful maintenance and STANDARD D&G Oil have teamed to deliver this performance at Graettinger. Maybe you would like to use STANDARD D&G Oil to obtain similar performance from your engines. A Standard Oil lubrication specialist is nearby in any of the 15 Midwest and Rocky Mountain states ready to show you. Call him. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.



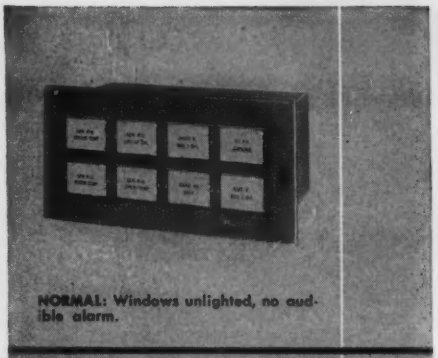
Piston of one of F-M engines at Graettinger Light Plant. STANDARD D&G Oil has kept maintenance down, cut piston and liner wear.

Standard man Bob Spargo (left) and plant superintendent Melvin Nissen inspect piston through crankcase inspection plate hole. With STANDARD D&G Oil, light plant has cut oil consumption in half.

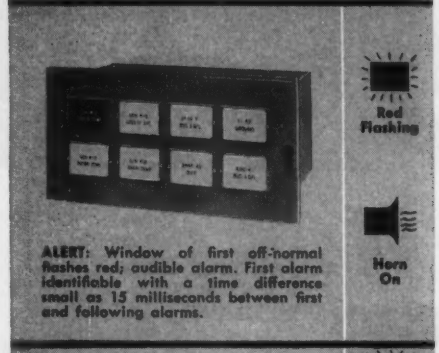
Quick facts about STANDARD D&G OIL	
1	Made from highest-quality solvent-refined stock.
2	Contains additives which impart superior detergent-dispersant and anti-corrosion properties.
3	Anti-foaming.
4	Oxidation resistant.
5	Recommended for use (1) with economy fuels, (2) in extreme-load and/or low temperature service.

STANDARD

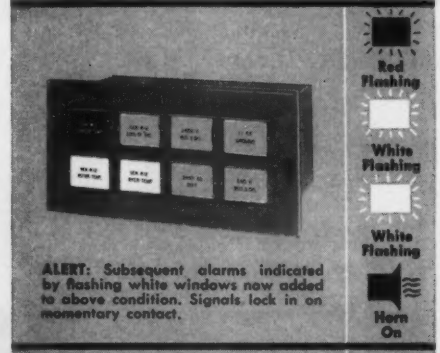
STANDARD OIL COMPANY
(Indiana)



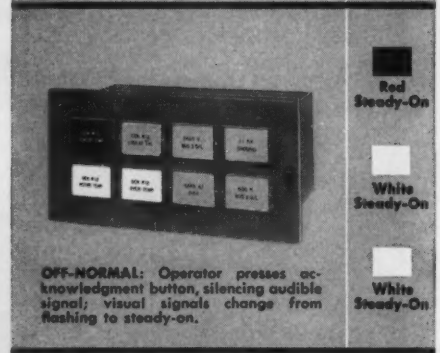
NORMAL: Windows unlighted, no audible alarm.



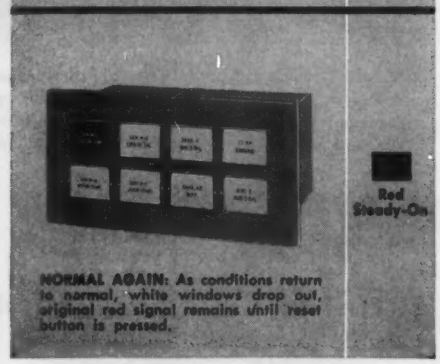
ALERT: Window of first off-normal flashes red; audible alarm. First alarm identifiable with a time difference small as 15 milliseconds between first and following alarms.



ALERT: Subsequent alarms indicated by flashing white windows now added to above condition. Signals lock in on momentary contact.



OFF-NORMAL: Operator presses acknowledgment button, silencing audible signal; visual signals change from flashing to steady-on.



NORMAL AGAIN: As conditions return to normal, white windows drop out, original red signal remains until reset button is pressed.

Panalarm "VS" Annunciator identifies first off-normal from subsequent alarms for rapid corrective action

You gain the control advantages of an audio-visual information system, not just an alarm system, with the Panalarm "50VS" Visual Sequence Annunciator. This is particularly valuable when one off-normal condition will cause a "chain-reaction" of off-normals. Typical Panalarm applications are found in the process industries and among users of automatic machinery.

The original off-normal is clearly identified, enabling the operator to take immediate, corrective action. A considerable saving in down-time can often be effected simply by knowing the original source of trouble.

Panalarm "50VS" is completely flexible in setting up various sequential groups. Any number or combination of signals may be grouped as an independent sequence, and the groupings may be changed at any time by simple jumpers on the terminal block. Signals may be either illuminated nameplate or bullseye indicators, combined with a horn, bell or other audible signal. Signaling is simple and positive. A typical sequence is illustrated on the left.

Write for literature on the "50VS" and other Panalarm Annunciator Systems. A Panellit sales engineer will be happy to make a survey of your production operation to determine whether a Panalarm system can help increase efficiency and safety in your plant.

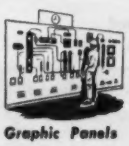
All Panalarm Annunciator Systems are completely modular, permitting future growth and changes. The photographs below illustrate a typical Panalarm Cabinet with illuminated nameplates and the hermetically sealed Panalarm "50" plug-in relay unit. Components throughout are ruggedly built to instrument standards for continuous, dependable duty. Entire Panalarm system is suitable for Class 1, Division 2 installations.

Listed by Underwriters' Laboratories

U.S. Patent No. Re-24,031

Engineered Information Systems for Industry

Panalog Information Systems



Graphic Panels Control Centers

Instrument Services Division

PANALARM

Division of

PANELLIT, INC.

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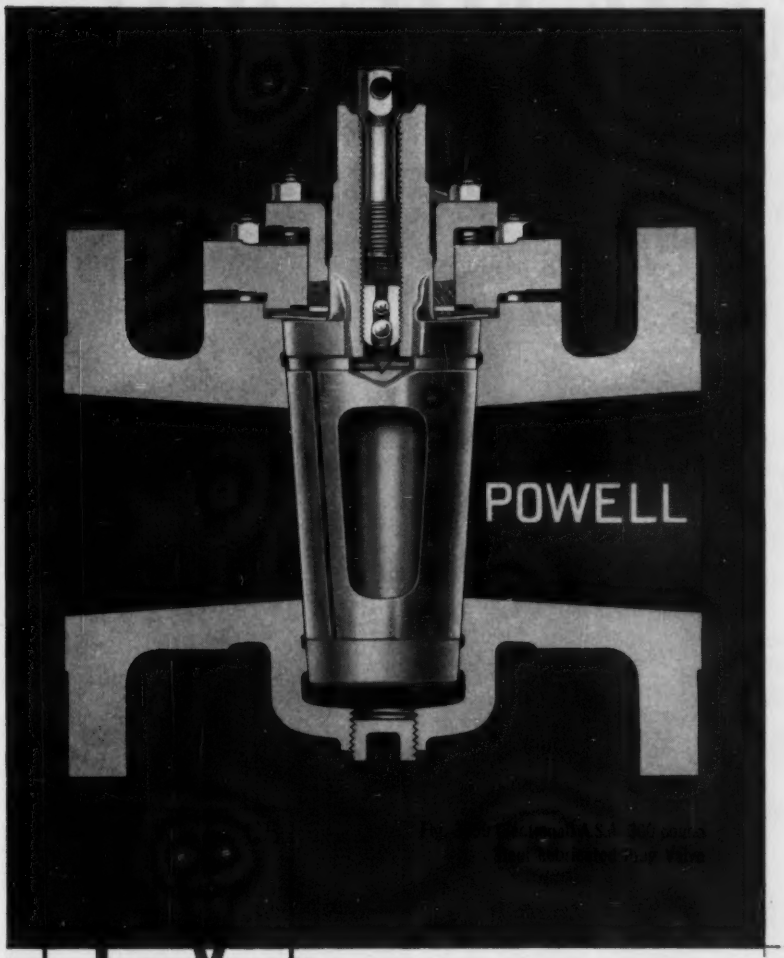
Skokie, Ill.

Panellit of Canada Ltd. Toronto 14

Powell Lubricated Plug Valves



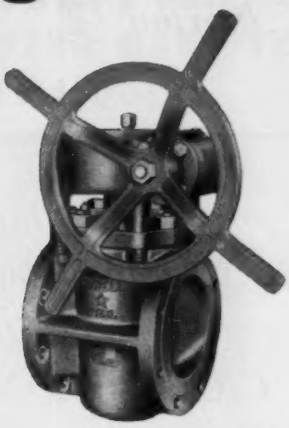


FIG. 1559G—150-pound Steel Lubricated Plug Valve. Gear operated

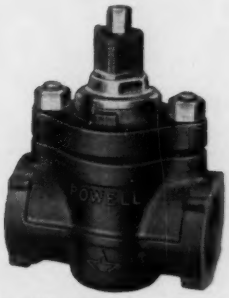


FIG. 2200—175-pound W.O.G. Semi-Steel Lubricated Plug Valve

VERIFIED

Powell Lubricated Plug Valves maintain the 110-year tradition of quality and precision. Only the finest available materials are used. And painstaking quality control is rigidly enforced through each and every step of manufacture.

Valve users who want one source of supply for lubricated plug as well as all types of bronze, iron, steel and corrosion-resistant valves will want full details on Powell Lubricated Plug Valves.

For example, features include quick and positive operation—just a quarter-turn to open or close. Lubricant grooves surrounding each port provide a positive seal when the valve is closed. In an open position, seating surfaces are not exposed. Available in Steel and Semi-Steel through distributors in principal cities.

For full details, write for the new PV-4 Catalog on Powell Lubricated Plug Valves. Just fill out the coupon and mail. Of course there's no charge, no obligation.

THE WM. POWELL COMPANY
2525 Spring Grove Ave.
Cincinnati 22, Ohio

Gentlemen:

Please send me a copy of your PV-4 Catalog on Powell Lubricated Plug Valves. It is understood that there is no cost, no obligation.

*name*_____

*title*_____

*company*_____

*city*_____

*zone*_____ *state*_____

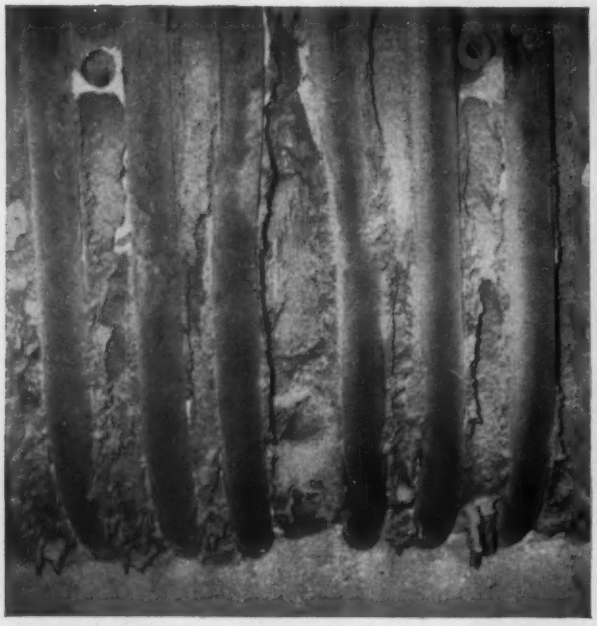
The source of supply for all valve needs!

POWELL VALVES...110th YEAR

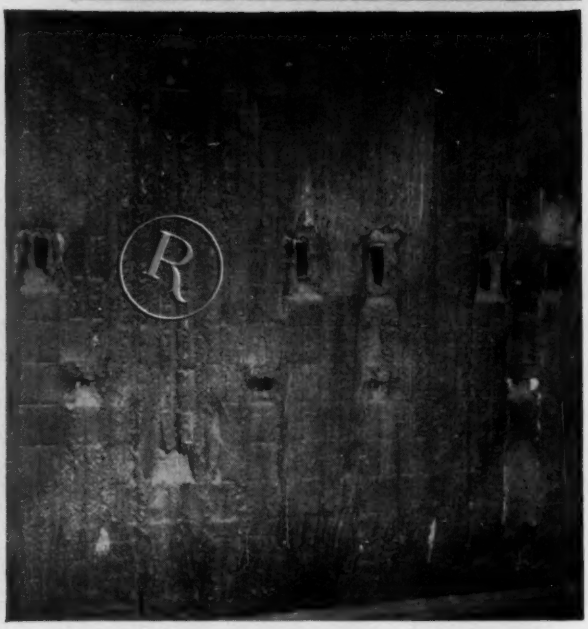
BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

Another Norton Rx *on the job!*

Power plant remedies inadequate boiler protection by switching to CRYSTOLON armor blocks*



Walls of water tube boilers were trouble spots in the modern plant of the Rural Cooperative Power Association in Elk River, Minnesota. This photo shows how the previously used refractory material broke down, after comparatively short service, under chemical attack by accumulated fly ash. Results of this inadequate refractory protection were inefficient heat transfer, low-capacity boiler operation and costly shut-downs for repairs. Compare this picture with the one at the right, taken at the same plant.



CRYSTOLON armor blocks provided the Rx. Photographed a year after installation, these rugged silicon carbide refractories look like new. Withstanding the attacks of fly ash, and enabling easy removal of slag, they reduce maintenance and downtime. And because of their high thermal conductivity they transmit heat uniformly to the boiler tubes — still another example of how Norton CRYSTOLON refractories provide maximum protection *plus* conduction.

Norton CRYSTOLON refractories, *engineered and prescribed* for better boiler performance, are characterized by exceptional hot strength, high refractoriness and thermal conductivity. They withstand the mechanical and chemical attacks of a wide variety of fuels and have great resistance to slag penetration, spalling and abrasion.

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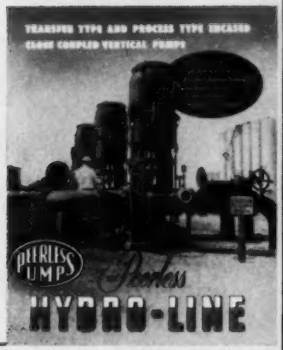

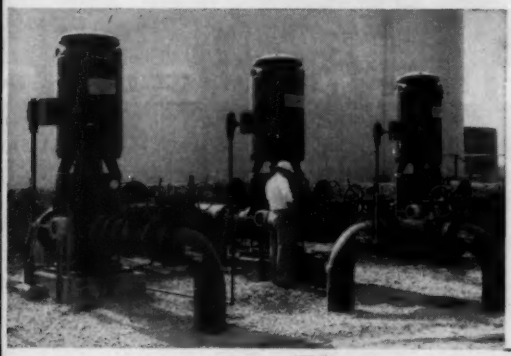

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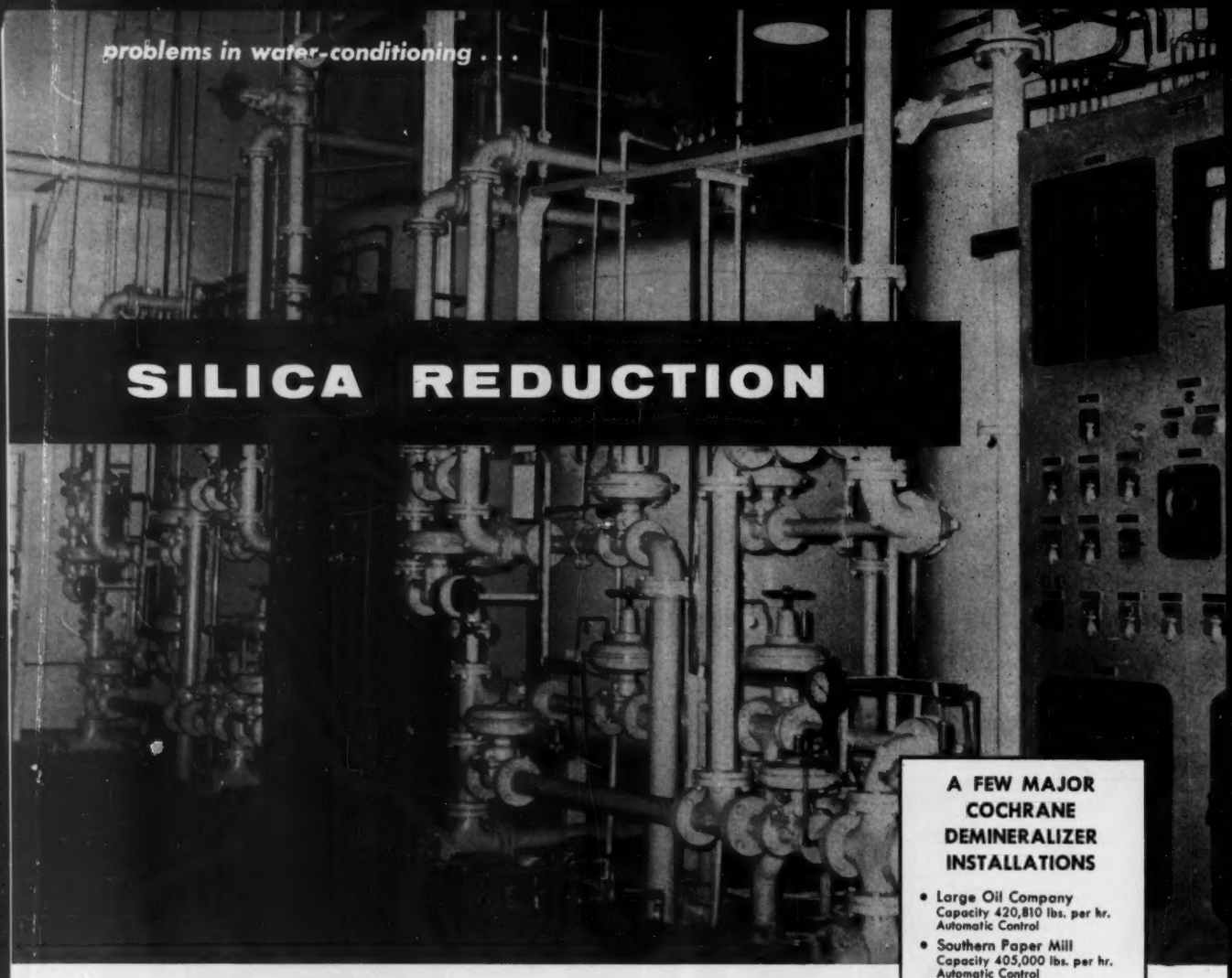

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LOUIS N ROWLEY, EDITOR • APRIL 1956 • ESTABLISHED 1882 **Power**

The fresh approach

ALTHOUGH I'm enough of a realist to know that we can expect more snow and cold weather, right now as I write, there's a feel of spring in the air on Long Island. For some days, a warm sun has thawed frozen soil, swollen the buds on trees and shrubs. It can't be long before we will see again the masses of yellow forsythia and the flowering fruit trees that herald spring in this little corner of the world.

This annual miracle of earth's regeneration, this sudden unleashing of energies dormant during cold winter months, has been the theme of many an editorial and sermon. A vast variety of lessons, both practical and metaphysical, have been drawn from it. Without any pretense to originality, I'd like to pass along some vagrant thoughts stirred by the coming change of season.

For all that spring's soft, warm air gives it a lazy, languorous feel, it's an incredibly active period in the natural world. There's a tremendous job to do, and only a short time to do it. The earth must be remade and Nature leaps to the task with irresistible energy.

So it should be with our own selves and our jobs. Most individuals and organizations have their dormant periods—times when things seem to be rocking along nicely on an even keel and the temptation is strong to let well enough alone. In nature, spring bursts on the world automatically and inevitably, just when it seems winter will last forever. But there is no such inevitable awakening when human affairs are allowed to hibernate. We must consciously break our easy-going patterns of habit, bring new energy to our daily lives and the organizations of which we are a part.

Let's not confuse this with change for the sake of change. Rather, let's recognize that we all run the risk of being lulled into false security by times when things go smoothly—let's cultivate the habit of the fresh approach that Nature takes each year.

Now, as the season changes, why not move in on some of those problems we've been mentally sweeping under the rug? That business of training an understudy to take over when we get the chance to step up a notch. That reorganization of the maintenance setup that's long overdue. That job of selling management on modernizing the electrical distribution system. You'll have your list of things that need doing, just as I have. Let's put some springtime energy into these long-postponed tasks and remake our own worlds for the better.

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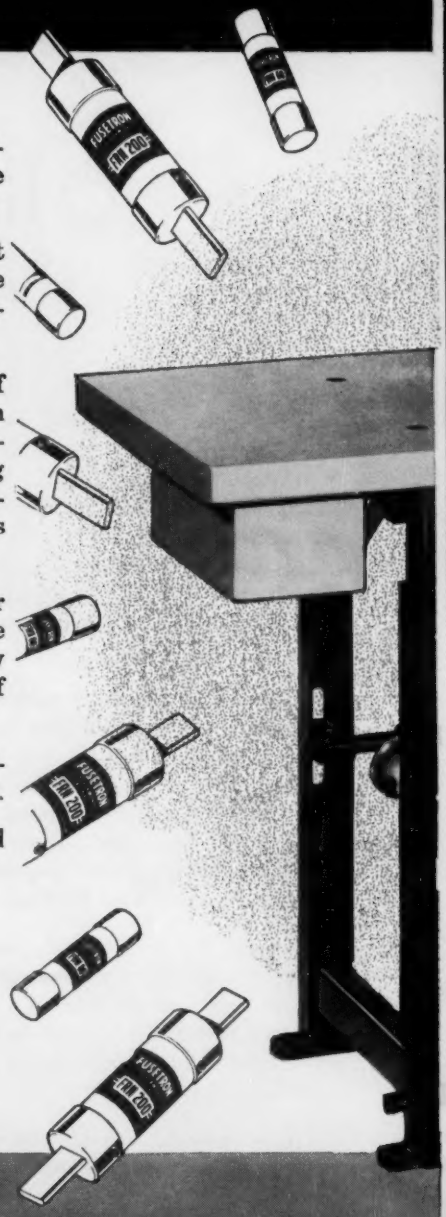

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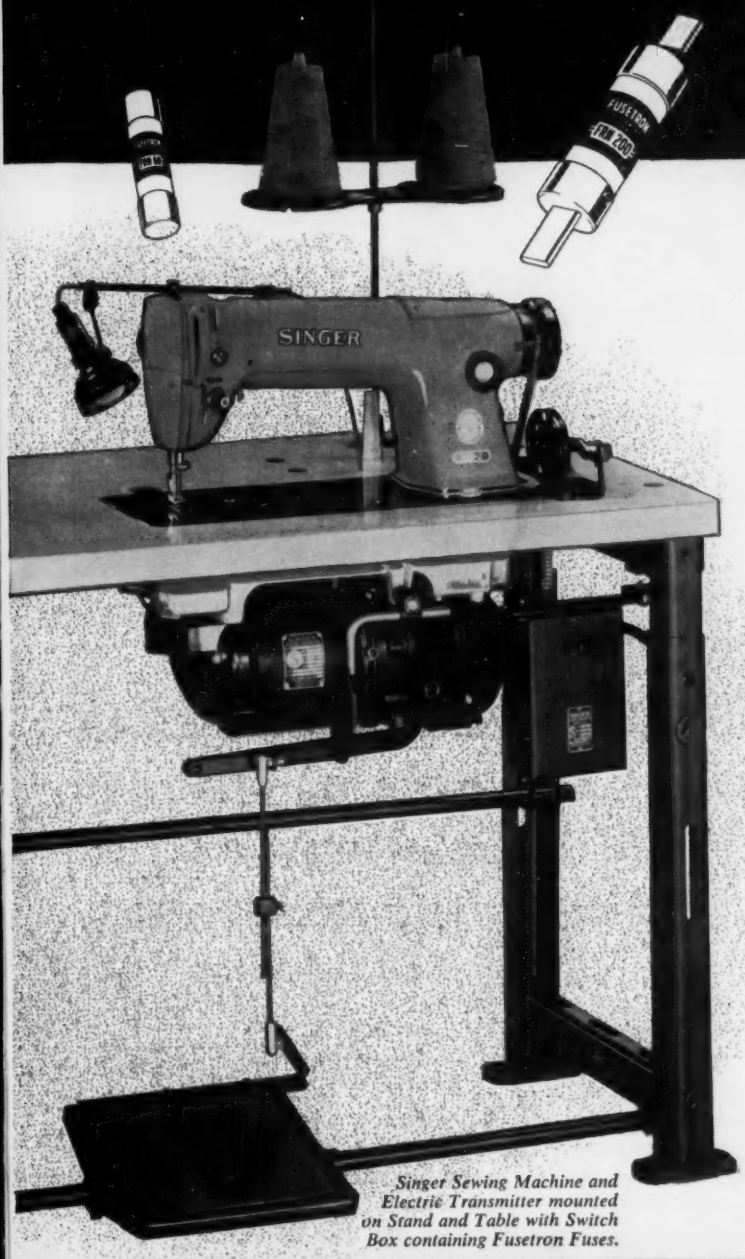

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On new construction, tell your architect to specify this Safer, Better Protection.

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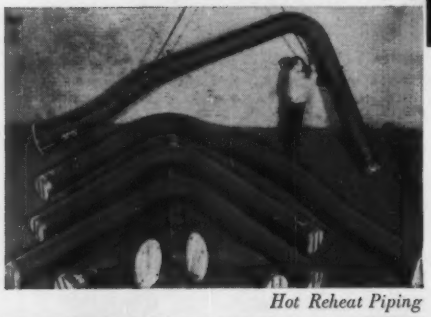
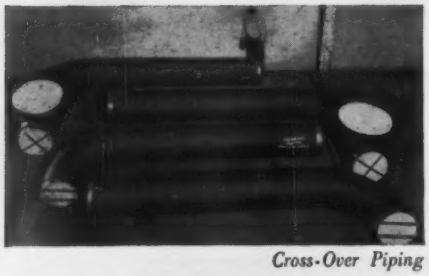


Hot Reheat Piping



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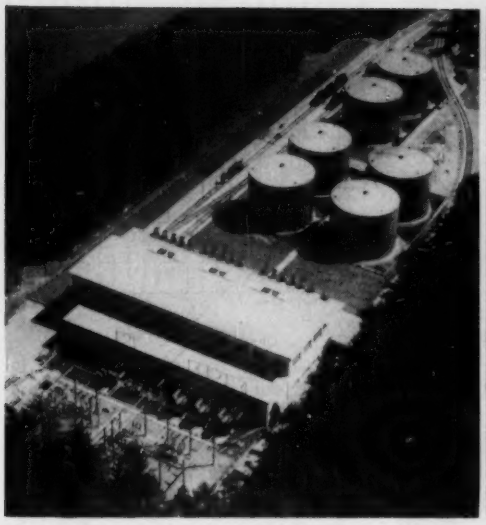


1 Beznau power station has total gas-turbine capacity of 40,000 kw in two 2-shaft reheat units

2 Machine room of Beznau has 27,000-kw unit standing in foreground with combustors at center; 13,000-kw unit stands in the background

Report on Beznau – largest of its kind

World's largest gas-turbine electric-generating station completes eight years of service as standby for hydro system. Here's a rundown on how the station performed and operated

By H PFENNINGER, *Chief Engineer*
Gas Turbine Design Department
Brown, Boveri & Co Ltd, Switzerland

► To MEET winter peak loads and extra demands for energy in dry years, the North-East Switzerland Electricity Works (NOK) decided in 1946 to build a thermal power station. After many studies a gas-turbine station was chosen.

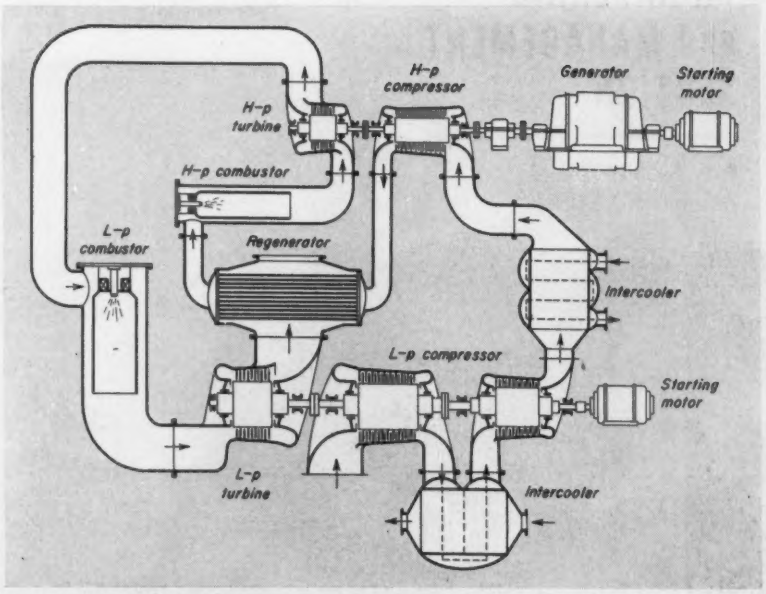
The hydro station at Beznau stands in the load center of the NOK service area and so this site was chosen for the thermal station too. The equipment contract was placed on June 30, 1946.

Machine sizes already built were selected to shorten the construction time as much as possible. Fig. 3 shows the cycle of the 13,000-kw unit, the biggest built to that time. To achieve the 27,000-kw capacity of the second unit, l-p compressors and l-p turbines were doubled and arranged in parallel flow.

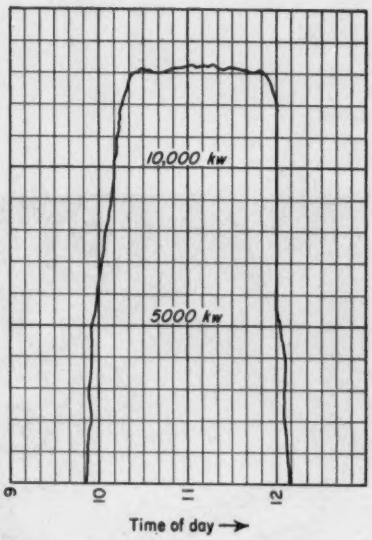
Originally, the machines were designed to run during the winter months only; so 41 F was used as the design-point temperature for inlet air and cooling water. Fig. 5 shows how these temperatures vary.

The 13,000-kw unit went into service in early 1948, about 18 months after the order was placed. The 27,000-kw unit started running in January 1949. These units run as needed, during the cooking peak in warm months, or for 1-, 2- and 3-shift operation in winter, Fig. 4, 6 and 7.

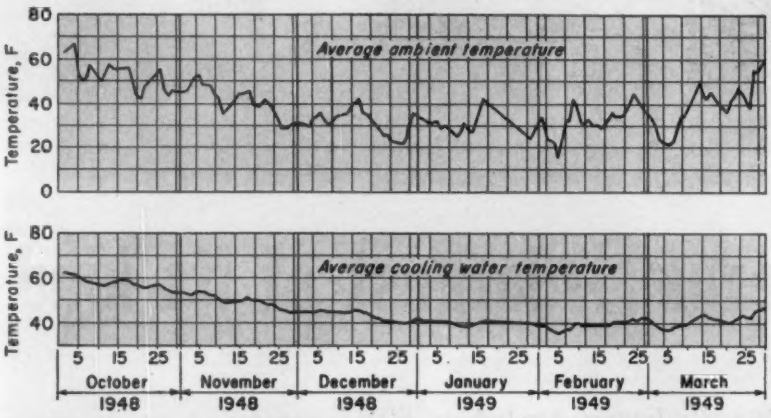
In summer when only one unit runs for the cooking peak, the generator of the other unit runs as a synchronous



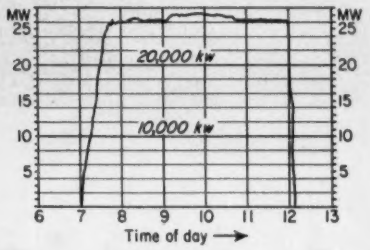
3 The 13,000-kw unit has two shafts, two intercoolers, reheat combustor and regenerator; 27,000-kw unit is similar, has double-flow l-p compressor, turbine



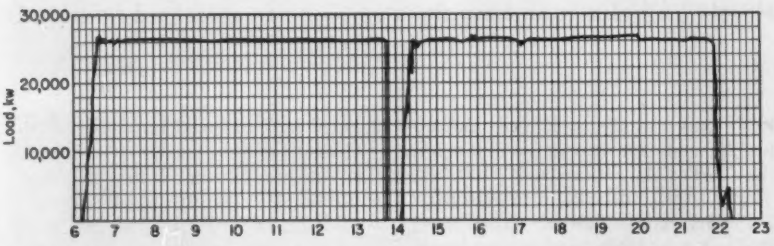
4 Typical loading of 13-mw unit to meet the cooking peak during April



5 Typical variation of air and cooling-water temperatures during fall and winter fixed the design point for both gas turbines; both factors averaged out at 41 F



6 Typical loading of 27-mw unit during one-shift operation to help hydros



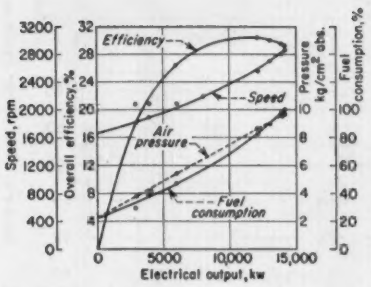
7 Typical December-day loading of 27,000-kw unit when it runs during most of three shifts. Hydro stations carry load variations while gas turbines carry base

condenser. These generators can do this job even when their turbines are out of service for overhauling. The generators have independent lubricating systems.

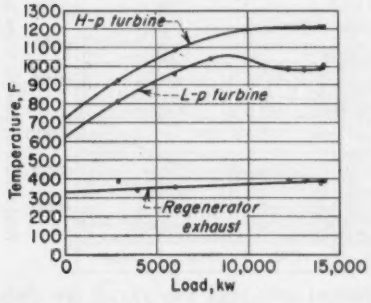
Operating costs. If we, at Brown Boveri, designed these units today, we would eliminate the regenerators, especially in view of the 2000 to 3000 running hours per year. Quantity deliveries of fuel oil in Switzerland cost about $23 per ton. With overall operating efficiency of about 28%, the fuel rate runs about 0.69 lb per kwhr. At a net heating value of 17,700 Btu per lb and the above fuel price, fuel cost runs about 0.7c per kwhr. Total production costs add up to about 1.25c per kwhr, including fixed charges. This assumes an annual running time of 2000 hr, and amortization period of 15 years. This cost easily competes with hydro power produced in storage plants. Fig. 10 shows the operation of Beznau since it started. The graph shows in effect a picture of the peak demands to be met and the water flow in the rivers. By the end of 1954 the plant generated over 290-million kwhr.

Beznau with an installed capacity of 40,000 kw holds the record as the largest electric-producing gas-turbine station in the world. Table 1 lists its operation. After eliminating a few initial difficulties by design modifications, the plant now completely meets the operating requirements. It burns the cheapest and lowest-quality fuel oils found in Switzerland, Table 2.

Acceptance tests were run on the 13,000-kw unit on Feb 15, 1951. The Swiss Association of Boiler Proprietors measured the fuel consumption, and



8 Test performance of 13-mw unit has high efficiency above ½ load



9 Turbine-inlet and regenerator-exhaust temperatures rise fast to half load

the Swiss Electrotechnical Association the output, Table 3. Fig. 8 shows that the overall thermal efficiency stays practically constant from 65% to full load. The no-load fuel consumption amounts to about 23% of the full-load rate.

A second set of tests were run after 7800 hr of service and generation of 74.5 million kwhr, last two columns of Table 3. The slight deterioration of performance lies within the accuracy of measurement.

Load-dumping tests showed the expected results. On throwing off full load the shaft speed rose to 8.75% above normal and then settled to 4.2% above normal. The final stable no-load speed was reached in 20 seconds.

Acceptance tests were made on the 27,000-kw unit on Sept 22, 1953, Table 4. At this time, the machine had run about 6000 hr and generated about 110-million kwhr. A second test was run on Aug. 4, 1954; up to that time the unit ran 8240 hr and produced 164.6 million kwhr.

The difference in these two tests was

1 — Beznau Station annual outputs

Unit	13,000 kw		27,000 kw		Total
Winter season*	Running hours	Million kwhr	Running hours	Million kwhr	Million kwhr
1947/48	285	2,608	–	–	2,608
1948/49	2,715	22,412	394	6,056	28,468
1949/50	2,537	24,727	1,873	36,014	60,741
1950/51	237	2,300	656	12,646	14,946
1951/52	1,811	20,697	1,989	37,256	57,953
1952/53	517	4,865	577	10,751	15,616
1953/54	2,800	30,000	2,600	63,100	93,100
1954/55	705	8,021	965	20,381	28,402
Totals	11,607	115,630	9,054	186,204	301,834

*Year ending April 30

2 — Beznau Station fuel-oil analysis

Fuel-oil number	3	4		5A	
Specific gravity at 68 F	0.921	0.924	0.924	0.937	0.937
Ignition point (open crucible), F	205	280	–	–	–
Pour point, F	–128	64	–	–	–
Viscosity at 68 F, centistokes	199	425	–	750	1193
Conradson test, %	7	5.7	–	6	6
Hard asphalt, %	6.3	1.25	12	–	–
Ash content, %	0.024	0.026	0.060	0.010	0.020
Sulfur content, %	1.77	1.9	–	2.5	2.5
Ash analysis:					
SiO_2, %	–	–	–	2.4	1.5
V_2O_5, %	37.0	26.5	21	23.2	18.0
NiO, %	6	–	4	3.8	3.0
Al_2O_3, %	–	–	11	1.8	trace
Fe_2O_3, %	7	–	6	3.1	12
CaO, %	–	–	0	0.9	3
MgO, %	–	–	0	0	4
SO_3, %	–	–	–	29.8	39.0
Na_2O, %	–	18.5[a]	–	38.0	20.0
Water solubility of ash, %	77	63.3	67.0	70.5	71.0
Lower heating value, Btu per lb	17,370	17,874	–	17,991	18,050

[a] Includes SO_3 as remainder

3 — Tests of 13,000-kw gas-turbine unit at Beznau Station

Date of test	Feb 15, 1951		Sept 23, 1952	
Test number	1	2	1	2
Net terminal output, kw	14,190	12,990	13,516	12,312
Fuel burned, lb per hr	9,177	8,289	9,264	8,337
Net heating value, Btu per lb	17,793	17,793	17,730	17,730
Total heat input, M Btu per hr	163,323	147,525	164,296	147,846
Ambient temperature, F	36.9	40.5	54.5	52
Cooling-water temperature, F	41.9	42.1	60.2	58.8
Oil-fuel number	4	4	4	4
Fuel specific gravity	0.906	0.906	0.908	0.908
Terminal output, corrected to guarantee, kw	14,140	12,950	14,230	12,850
Overall thermal efficiency, %	29.6	30.1	29.6	29.8

4 — Acceptance tests of 27,000-kw gas-turbine unit

	Provisional acceptance tests: Sept 22, 1953		Final acceptance tests, August 4, 1954	
Net terminal output, kw	25,050	29,200	23,562	24,469
Fuel burned, lb per hr	16,714	20,176	16,584	17,551
Net heating value, Btu per lb	17,640	17,640	17,694	17,694
Heat input, million Btu per hr	294.89	356.03	293.50	310.61
Fuel-oil number	5	5	3, 4, 5[a]	3, 4, 5[a]
Fuel specific gravity at 122 F	0.921	0.921	0.919	0.919
Ambient temperature, F	57.7	58.7	71.6	78.6
Cooling-water temperature, F	63.1	63.1	67.6	68.4
Uncorrected thermal effy, %	29.0	28.0	27.4	26.1
Corrected net output, kw	26,600	31,050	26,230	27,820
Corrected thermal effy[b], %	31.0	29.9	30.0	29.7

[a] Fuel oils mixed

[b] Corrected to guarantee conditions

Note: Machine became slightly fouled between tests. Also, it was altered during this time to run more economically at ambients above 59 F and to run more reliably.

caused by a few modifications on this unit. These were made to increase the machine reliability and to maintain economical operation at higher air temperatures than the 41-F design point. The latter was done at the request of NOK. As a result, at 41 F the inlet-gas temperature to the l-p turbine has to be kept somewhat lower. This requirement restricts the maximum output and maximum overall thermal efficiency.

Operating the units has been simple. One operator starts up a unit. Operating labor costs about $36,000 per year. A similar-size steam station would need about $100,000 operating labor a year.

For the gas-turbine station, yearly labor costs amount to 90c per installed kw yearly. With a running time of 2000 hr per yr the labor costs are 0.45 mills per kwhr; with 6000 hr per yr this cost drops to 0.15 mills per kwhr. Corresponding costs for a steam-turbine power station of the same capacity and output amount to $2.50 per kw-year; 1.25 mills per kwhr and 0.42 mills per kwhr.

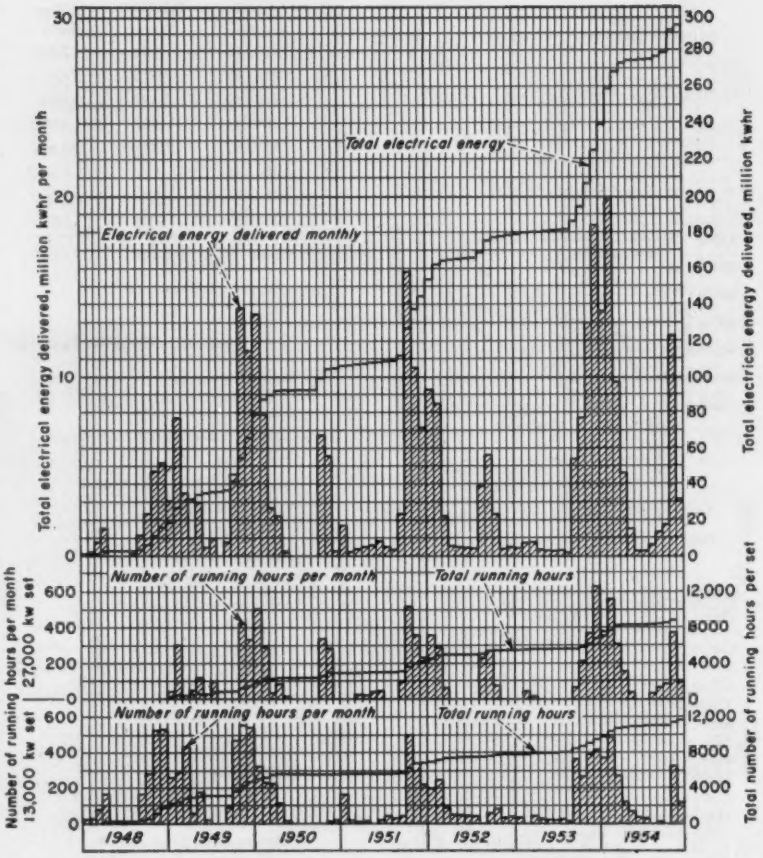
Maintaining the plant involves: (1) periodic inspection of combustion chambers (2) periodic inspection of fuel nozzles (3) cleaning of fuel tanks (4) regular washing of turbine blading to remove fuel deposits (5) scheduled cleaning of regenerator tubes by soot blowers while unit runs under load.

At longer intervals the air coolers, regenerators, and control and safety apparatus are inspected. The fuel lines, pumps and filters must be cleaned. The compressors are inspected and cleaned as found necessary. The gas turbines are inspected from time to time, but at fairly long intervals.

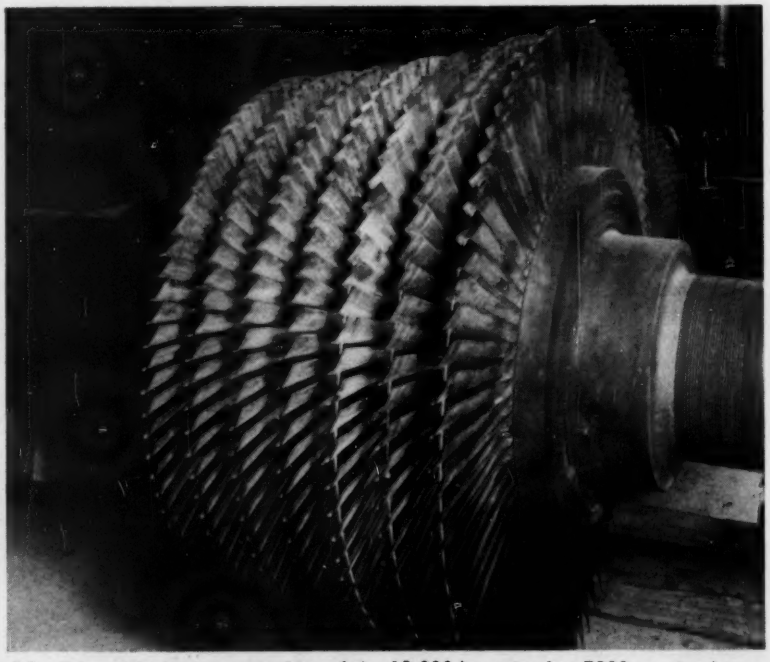
When the turbine rotors of the 13,000-kw unit were inspected after 7900 hr service both were found in good condition, Fig. 11. At the same time, a few of the regenerator tubes were removed and inspected. They were in very good condition—no reduction in tube-wall thickness was found.

We didn't expect to find any corrosion of the regenerator tubes since the average temperature of the tube walls at the hot-gas inlet runs about 680 F and about 300 F at the outlet. Danger of corrosion prevails when the unit stands idle because of atmospheric moisture. Although the units run only about 2000 hr a year, the tubes still show no sign of corrosion after seven years of service.

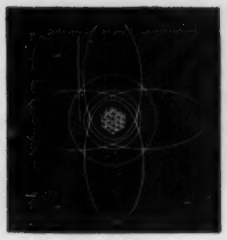
The economy and operating results of the Beznau Station experience demonstrate the ability of the gas turbine to carry seasonal peak loads.



10 Output and running hours record of Beznau units since they started operation for first seven years. Units run only (1) on peak and (2) when hydro is short



11 Rotor of high-pressure turbine of the 13,000-kw unit after 7900 running hours. No corrosion was found on blading or rotors despite heavy fuel oil burned



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Racing for first place to produce energy from a privately financed atomic plant, General Electric Co plans to build experimental reactor 40 miles southeast of San Francisco, Calif. Reactor will feed steam to Pacific Gas & Electric Co's turbine-generator plant, send as much as 5000 kw into utility system. Reactor plant is planned to run by 1957—will be pilot model for Commonwealth Edison's 180,000-kw dual-cycle boiling-water reactor. AEC must still approve.

Atomic power plant for Florida, maybe as big as 200,000 kw, is in the future with target date of 1962-63. Three companies—Florida Power & Light Co, Miami; Tampa Electric Co, Tampa; Florida Power Corp, St. Petersburg—have made an agreement with Allis-Chalmers Mfg Co and Babcock & Wilcox Co to design and build an atomic power plant at suitable transmission distance from all three systems. Stone & Webster Engineering Corp might be consultants.

Seven public power groups have proposed atomic power plants for AEC Power Demonstration Program: (1) Rural Cooperative Power Assoc, Elk River, Minn., 22-mw boiling-water reactor (2) University of Florida, Gainesville, Fla., 2-mw pressurized-water reactor (3) Piqua, Ohio, 12.5-mw organic-moderated reactor (4) Wolverine Electric Cooperative, Hersey, Mich., 10-mw aqueous homogeneous reactor (5) Orlando, Fla., 25-40-mw liquid-metal fueled reactor (6) Holyoke, Mass., 15-mw gas-cooled reactor (7) Chuqach Electrical Assoc, Anchorage, Alaska, 10-mw sodium-cooled heavy-water reactor.

Nuclear danger area has been declared by the AEC in getting ready for bomb tests at the Eniwetok Proving Ground in the North Pacific Ocean. The area covers about 375,000 nautical square miles. Weapons tested will be smaller than those blasted in 1954. Danger period will run from April 20 to August 30, 1956.

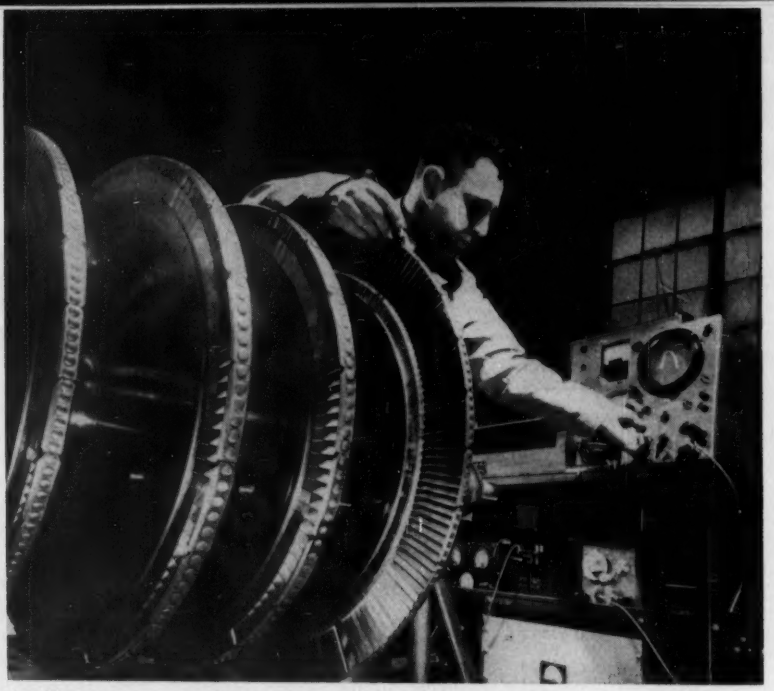
Licensing gives no right to AEC to claim ownership of any nuclear invention or discovery made by the licensee. Such rights exist only when a licensee has made a "contract, subcontract, arrangement or other relationship with the Commission." This opinion of William Mitchell, general counsel of AEC, was published in the *Federal Register* on March 2, 1956.

High-voltage electricity can be drawn from a nuclear reactor. Patent 2,728,867, issued to V C Wilson on Dec 27, 1955, describes a method of placing collectors close to fissioning material. These gather the beta rays (high-speed free electrons) released by fissioning and conduct them to terminals for connection to external electrical circuits. Cylindrical beta collectors, which surround the fissionable reactor elements, are made of copper, aluminum, beryllium or other conducting material. Insulation between collectors and fuel elements may be a vacuum, or quartz, mica, polystyrene.

Atomic Industrial Forum will meet in Chicago, Ill. on Sept 25, 26 and 27, 1956. Headquarters and technical sessions will be held at the Morrison Hotel, while the second annual Atomic Industry Trade Fair will be held at the Navy Pier.

Free World uranium industry does an annual business of about $500 million. Of this total, U.S. share runs about $200 million. Economy of some areas in our Western states depends heavily on uranium mining and milling operations.

By **W J CARUSO**, *Engineer*
General Electric Company
Fitchburg, Mass.



1 Vibration test on high-speed mechanical-drive turbine buckets uses electronic equipment to induce known frequencies and measure resulting bucket response

How to lick turbine-bucket vibrations

Turbine-bucket failures can be avoided by knowing what causes destructive resonant vibrations. A new test procedure that tailors nozzle design to turbine-bucket needs solves the problem

► BUCKET VIBRATION becomes a serious problem when the vibration amplitudes cause alternating stresses that exceed the fatigue strength of the material. Vibration amplitudes big enough to cause fatigue failures may happen under conditions of "resonance." For this condition the stimulating force must have a frequency coinciding with one of the natural frequencies of a bucket.

In a steam turbine, the buckets, as they pass the nozzles, get a series of impulses from the disturbances or wakes in the steam flow caused by the nozzle partitions. These successions of impulses act as the stimulating force. The rate at which the buckets receive the impulses sets the frequency of the stimulating force. It depends on both the rotor speed and the number of nozzles in the diaphragm.

We'll call the speed in revolutions per second multiplied by the number of nozzles the "nozzle passing frequency." If this frequency coincides with a bucket natural frequency, then a condition of resonance or resonant vibration exists.

In relatively low-power low-speed machines resonant vibration may be of little concern. The stimulating forces set up vibrations too small to cause bucket failure. Either "beefing up" the bucket design or using stronger buckets will eliminate any occasional failures that may occur.

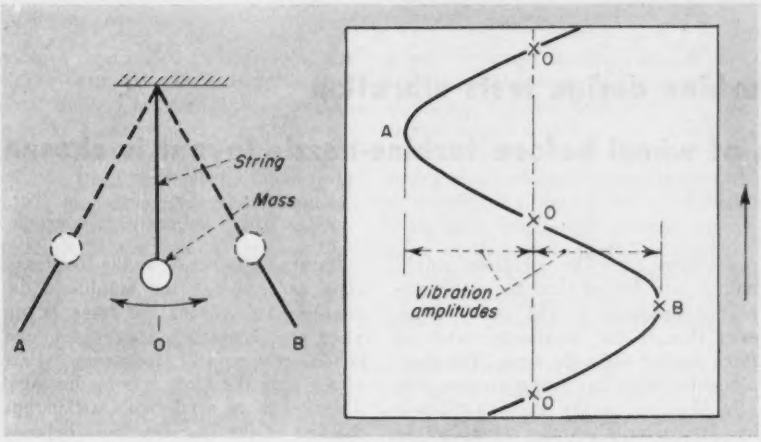
Current trend calls for more-powerful higher-speed higher-temperature turbines. The forces on the buckets make the problem of resonant vibration increasingly important. Loss of a bucket, or part of a shroud band, may cause large unbalanced forces in the rotor so the turbine must be shut down to prevent further damage. This might mean shutting down a production line or a generating station at great cost.

Unfortunately, using stronger buckets may no longer be the answer. Changes in natural frequencies with change in bucket design may create a "frying pan into the fire" situation. Operating efficiency and manufacturing cost impose definite limitations on bucket design. A more effectve use of bucket design must be made.

Vibration. Let's start with some easy examples to understand vibration. Fig. 2 shows a simple pendulum. Without air resistance and no friction, the pendulum will move back and forth indefinitely once it is set swinging.

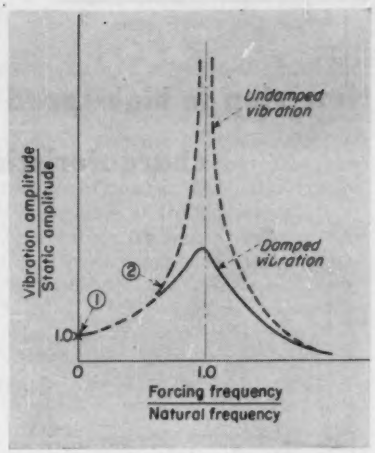
A pendulum bob hanging straight down is in its equilibrium position *O*. When displaced to one side *A* and released, it swings through *O* and continues an equal distance to the other side *B*. It then swings back through *O* to *A*. With no friction and air resistance the pendulum swings back and forth indefinitely from *A* to *B* to *A*.

This ideal motion is a free, undamped vibration. It is *free* because once the pendulum starts swinging, no further external forces are applied to it. It is

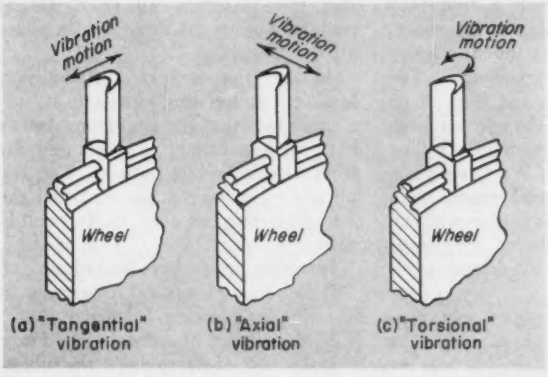


2 Simple pendulum acts as vibrating system, moving from *A* to *B*

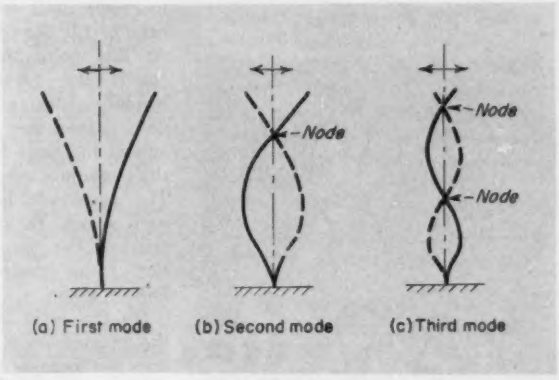
3 Pendulum action could be traced as simple sinusoidal (harmonic) motion



4 Resonance curves of simple vibrating system can be damped or undamped



5 Single turbine bucket can vibrate in three ways (*a*) tangential (*b*) axial (*c*) torsional, or in any combination



6 Deflection shapes of a bucket vary as it vibrates tangentially in: (*a*) first mode (*b*) second mode (*c*) third mode

undamped because there are no frictional losses.

This example demonstrates two properties of vibration: the motion is both *periodic* and *harmonic*. A periodic or cyclic motion continually repeats itself in identical intervals of time. In our pendulum if we measure the time for it to complete one cycle from *A* to *B* to *A*, we will know its *period*. During the period the pendulum moves through one vibration cycle. Each subsequent cycle has the same period. *Natural frequency* of vibration is the number of free vibration cycles occurring in some unit of time.

In *harmonic* motion the displacement of an object from its equilibrium position varies sinusoidally with time. In Fig. 2, imagine that the bob has a pen attached to it so it traces a line on a curved piece of paper underneath it. Moving the paper at a constant rate, as the pendulum swings, the pen will draw a sine wave as in Fig. 3.

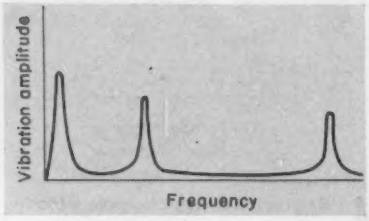
At *A* the pendulum reaches a maximum amplitude relative to its equilibrium position *O*. As it swings to *B* the amplitude is again a maximum, but in the opposite direction. In general, *vibration amplitude* refers to maximum displacement without regard to direction. This single amplitude contrasts to the peak-to-peak or double amplitude, movement from *A* to *B*.

Resonant vibration. The vertical axis of Fig. 4 gives the ratio of maximum vibration amplitude to static amplitude, called the *magnification factor*. The horizontal axis gives the ratio of the frequency of the stimulus to the natural frequency of the pendulum. The dotted curve shows a case of undamped vibration and the solid curve shows the effect of damping. These curves are magnification or resonance curves.

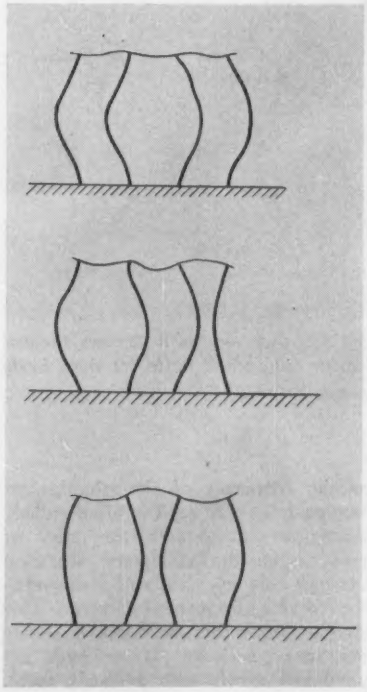
Since the natural frequency of a pendulum stays constant, the value along the horizontal axis varies only as the frequency of the stimulus, or forcing frequency as it is often called; this is the numerator of the ratio. At point *1* on the undamped vibration curve, a frequency ratio of zero means the forcing frequency is zero. This simply means that the force is steady instead of periodic. If we push the pendulum slowly with a steady force, the pendulum is displaced a certain distance and held there by the force. This amplitude of displacement is the static amplitude. The ratio on the vertical axis for this condition equals 1.0.

Now let's apply a harmonic, periodic force with a maximum value equal to the previous steady force. If the forcing frequency is much lower than the pendulum's natural frequency, the frequency ratio will be greater than zero but less than 1.0. For example, at point 2 on the undamped curve, as the frequency ratio rises from zero, the ratio of vibration to static amplitudes

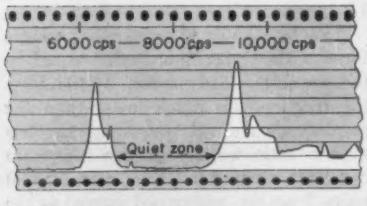
New step in high-speed turbine design tests vibration characteristics of wheel before turbine-nozzle layout is chosen



7 Resonance curves show vibrating system with several peaks and modes



8 Four buckets banded together have different vibration configurations



9 Test-vibration record spots quiet zones that control the nozzle design

rises from 1.0. The vibration amplitude is now bigger than the static amplitude produced by the steady force, even though the maximum value of force applied stays the same. The magnification factor has grown greater than 1.0. Multiplying the static amplitude by this factor gives the actual amplitude—that is, the static amplitude is "magnified" by this factor.

As we raise the frequency of the applied force, the maximum amplitude increases until we reach a frequency ratio of 1.0, the condition of resonance. At this point the forcing frequency equals the natural frequency. The pendulum swings back and forth at its natural frequency and the applied force acts at the same frequency. Each time the pendulum swings it is given a push. The amplitude becomes greater with each swing. In an ideal case with no friction, the amplitude or magnification factor theoretically becomes infinitely great.

On the curve for damped vibration, the magnification factor at resonance does not increase infinitely, but reaches a definite value. The magnification factor is limited only by the amount of damping in the vibrating system.

In an actual pendulum we can measure the damping by displacing the pendulum to one side, releasing it, and observing the maximum amplitude of each successive cycle. The damping will decrease the amplitude of successive swings until the pendulum comes to rest at its equilibrium position. The rate of amplitude decrease measures the damping. For the pendulum, the damping consists of friction in the system and the resistance of the air as the pendulum moves through it. Fig. 4 shows the importance of vibration damping in limiting the resonant amplitude. With turbine buckets, however, the amount of existing damping may be quite small.

A child's swing demonstrates a case of resonant vibration. If we want to move it through a wide arc, we stand behind it and push each time just as it starts to move forward from its maximum rearward position. Its arc of swing increases after each push until it reaches a maximum amplitude limited by the friction forces (damping) opposing and balancing our push.

Returning to Fig. 4, as the frequency ratio exceeds 1.0, the amplitude decreases. This means the force is applied at a frequency greater than the pendulum's natural frequency. Part of the time the force acts in the same direction as the pendulum's motion, but the rest of the time the force opposes the motion. This represents an "in phase" and "out of phase" relationship of the force to the velocity of motion. This prevents the amplitude of vibration from building up as it did at resonance when the force acts in phase all the time.

As the frequency ratio grows very large, the stimulating force acts at such a rapid rate that the pendulum doesn't have an opportunity to move very far from its equilibrium position. The amplitude ratio approaches zero and the pendulum remains close to its equilibrium position.

Summing up we have looked at:

1. Relation of natural frequency of vibration and forcing frequency.
2. Magnitude of stimulating force.
3. Amount of damping in the vibrating system.

In general, these three items have the same effect on vibration amplitudes and stresses of both simple and complex systems. These three items indicate the three possible approaches toward controlling vibration problems.

Our approach here avoids resonant vibration through properly relating natural and stimulating frequencies. We won't discuss any further the possibilities of decreasing stimulating forces or increasing system damping.

Avoiding resonant vibration in turbine buckets is not as easy as in a simple pendulum. To understand this let's study the vibrations in a single turbine bucket and in a full row of buckets on a turbine wheel.

Single-bucket vibration. A pendulum has only one natural frequency, depending on the length of the supporting string. On the other hand, a single turbine bucket has an infinite number of natural frequencies. Bucket height has the greatest influence on natural frequency; other factors include geometry of the bucket cross section and type of bucket material.

Fig. 5 shows the three directions in which a bucket can vibrate when

mounted on a turbine wheel. In *a*, the bucket vibrates tangentially to the wheel rim—called *tangential* vibration. In *b*, the bucket vibrates parallel to the direction of the wheel shaft—*axial* vibration. In *c*, the bucket vibrates with a twisting motion—*torsional* vibration.

Tangential vibration. The bucket structure usually has its greatest flexibility in the tangential direction. If a steady force were applied to the bucket tip in each of the three possible directions of vibration, deflection in the tangential direction would be greatest. Accordingly, the lowest natural frequency of the bucket will also be in this direction. This is called the first or fundamental tangential mode of vibration.

Fig. 6*a* shows the motion and shape in which a bucket deflects in tangential vibration, known as the first tangential mode. Fig. 6*b* and *c* show the second and third tangential modes. The second mode occurs at a natural frequency about 6.25 times the first mode; the third mode is about 17.55 times the first. There will also be 4th, 5th, 6th, etc, tangential modes occurring at still higher natural frequencies.

What's the difference between these modes? In the second mode deflection a point of the bucket between root and tip remains at its equilibrium position even when the remainder of the bucket is deflected in vibration. This point is called a *node* or *nodal point*.

The number of nodes depends on the vibration mode. The first mode has no nodes between bucket root and tip, Fig. 6*a*. The second mode has one node, Fig. 6*b*. The third mode has two nodes, Fig. 6*c* In general, the number of nodes is one less than the number of the vibration mode.

You will recall that the pendulum had one natural frequency and a single resonance curve associated with that frequency. For a turbine bucket the picture is more complicated because there are many natural frequencies. Each natural frequency has a resonance curve. If we apply a stimulating force to the bucket and gradually increase its frequency over a range or *spectrum*, we find several resonances. These occur at rather widely spaced intervals in the spectrum, Fig. 7. The vibration amplitude rises to a peak at each resonant frequency and drops to a low level when the forcing frequency differs from the natural frequency. Valleys between resonant peaks show frequency ranges in which the vibration amplitudes are small. If the forcing frequency falls within one of these ranges the vibration amplitudes will be small.

To avoid large resonant vibration amplitudes we must know the natural frequencies and control the forcing frequency to avoid coinciding with any of them. We must first know what modes and frequencies to expect in the turbine wheel.

In addition to the series of tangential modes of vibration, however, there will be a series of vibration modes for each of the axial and torsional types. These occur at their own particular natural frequencies so there will be many more resonance peaks in the frequency spectrum than those for tangential vibration only.

Turbine-wheel vibration. The situation becomes more complex for a full row of steam-turbine buckets assembled on a wheel. To improve thermodynamic efficiency the buckets are covered by shroud bands fastened to their tops. Each band covers a group of several buckets, so a wheel has many groups of banded buckets.

A single bucket has many natural frequencies, but when buckets are assembled in a wheel, there are a great many more natural frequencies to contend with. Some additional frequencies exist only in banded buckets on a wheel. These are called: (1) banded bucket modes (2) axial group modes (3) wheel modes. Another important consideration is the effect of "coupling" on the individual bucket frequencies.

In banded bucket modes there are nodes at the bucket root and tip. The bucket behaves like a beam fixed at the root and supported at the tip. Each mode has several configurations in which the buckets in the group vibrate. The buckets vibrate with various instantaneous in-phase and out-of-phase relationships with one another, Fig. 9. Each of these modes has a number of possible configurations equal to one less than the number of buckets banded together in a group. Each configuration has a slightly different frequency. So each mode covers a band of several frequencies.

In axial group modes the banded groups of buckets vibrate as individual systems. The motion is in an axial direction.

In wheel modes the buckets act as extensions of the wheel that is vibrating. The vibration motion is also in the axial direction.

Coupling combines or joins individual vibrating systems. In a turbine wheel the buckets are coupled to one another through both the wheel rim and the shroud bands. Coupling increases the band width of natural frequencies. If two buckets have nearly the same natural frequency when uncoupled, coupling them will create two different natural frequencies, one will be higher and the other lower than the uncoupled frequencies. Coupling all the buckets in a wheel results in a band of natural frequencies.

There will also be coupling or compounding between different modes of vibration that have nearly the same natural frequency. This also creates a wider band of frequencies.

Since there are so many different natural frequencies it would seem impossible to avoid a coincidence between the forcing frequency and at least one of the natural frequencies.

Quiet zones. The picture brightens, however, when we learn that many of the vibration modes are not easily excited and so do not attain large vibration amplitudes, even at resonance. Pursuing this approach further we find that there are usually several bands of frequencies spaced throughout the entire spectrum within which the vibration amplitudes are small. Fig. 9 shows these regions or "quiet zones."

To avoid dangerous bucket vibrations we must first know at what frequencies quiet zones occur. Modern electronic test equipment can locate them experimentally. The test equipment consists of:

1. A variable frequency oscillator that generates an electric signal.
2. A power amplifier that boosts the signal power.
3. An electromagnet that transforms the electric signal into a vibratory force on the buckets.
4. A vibration pickup that transfers vibratory motion of the buckets into an electric signal.
5. A high-speed level recorder that automatically makes a record of vibration amplitudes of the buckets at various forcing frequencies.

Fig. 1 shows some of this equipment being used on a vibration test of a turbine wheel.

Fig. 9 shows a portion of a typical vibration record. The vertical axis shows the vibration amplitude of a bucket and the horizontal axis shows the frequencies. Several resonance peaks appear that correspond to natural frequencies of the bucket. These peaks show large vibration amplitudes of the bucket and hence large vibration stresses. A quiet zone shows vibrations with small amplitudes. To find quiet zones for all the buckets, several vibration records must be made for a number of different buckets at various locations. This represents a statistical survey of the vibration characteristics of all the buckets, from which the quiet zones may be found.

Having found the quiet zones, the final step adjusts the forcing frequency so that it occurs within one of these zones during turbine operation. If this

(*Continued on page* 210)

FOR IMPROVED WATER SERVICES The Champion Paper and Fiber Co's Carolina division receives its 1955 modernization award from Howie Kallen, *right*, Power's Associate Editor. H Helder, *left*, and H Seaman accept the citation for Champion

Your opportunity to help fellow engineers . . .
Your opportunity to win recognition

There's still time to enter the 1956 program of modernization awards

► As INDUSTRY GEARS ITSELF to set new record highs in production, the power services are becoming more important than ever. The enthusiastic response to POWER's 1955 Modernization Award program demonstrated this fact conclusively.

This year, as part of a continuing policy, we again offer the POWER awards for modernization. They're designed to recognize companies that have displayed ingenuity, sound engineering judgment in carrying out modernizing programs *and* to show potential modernizers what can be done in their own plants. Small plants will be given the same consideration as large ones.

Remember, entries are invited in one or more of the following services: boiler plant, generating equipment, electrical distribution, building or process heating, air conditioning, refrigeration, compressed air, mechanical power transmission, water services. Electrical generation entries may be steam, diesel or hydro.

Most entries naturally come from power-service staffs, consultants. But we'll welcome leads from anyone in the power field.

How to submit entries

1. To enter, just say, "I'd like a 1956 Modernization Award blank," and address your card or note to:

Modernization Award Committee
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McGraw-Hill Publishing Co, Inc
330 West 42nd Street
New York 36, N. Y.

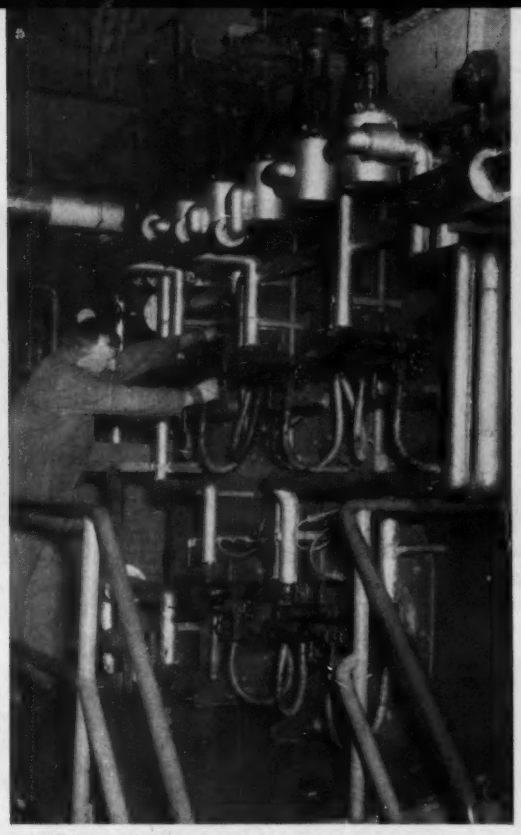
2. The entry blank you receive will contain a series of streamlined questions to make it easy for you to tell us about the modernizing job and its results.

3. In general, the kind of information we ask for will tell us (1) what was modernized (2) principal reasons for modernizing (3) what results were achieved (4) the unique features of the job, and (5) what unusual or difficult problems were solved.

4. Closing date is May 15, 1956.

5. Announcements of award winners will be made in POWER's 1956 Mid-September Modern Plant issue.

6. Arrangements for presentation of the awards will be made to suit the mutual convenience of the recipients and the POWER staff.



OIL-FIRED BOILERS all use Y-jet steam-atomizing burners and have complete combustion-control systems

Higher thermal efficiency . . . more generating capacity . . . less maintenance

Converting boilers to oil firing cuts power costs at this plant

► CHEMICAL DIVISION of Merck & Co, Inc, Rahway, N. J. decided that converting from coal to oil firing in their central powerhouse would produce savings. The predictions have come true.

Here are the benefits: more efficient use of manpower; maintenance costs down 30%; thermal efficiency of two low-pressure boilers increased 15%; plant steam-generating capacity up 10%; electric-generating capacity up 10%. Savings should pay for the conversion within three years.

Here's condition of the powerhouse at start of the study, and the thinking that went into conversion:

There were six coal-fired boilers and two separate coal-handling systems. The four older boilers operated at 125 psig. Two had capacities of 30,000; the third, 60,000; the fourth, 100,000 lb per hr. Two newer units produced steam at 450 psig for electric generation and process demands. Capacities were 100,000 and 75,000 lb per hr.

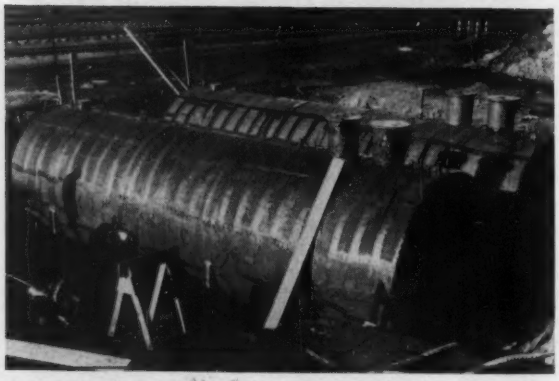
In operation, the two high-pressure boilers tended to lose capacity when on the line for some time. This decreased generated electricity and increased the plant's purchased-power requirements.

Planning the conversion. When plans were made, the delivered price of bunker-C oil, on a Btu basis, was lower than price of bituminous coal.

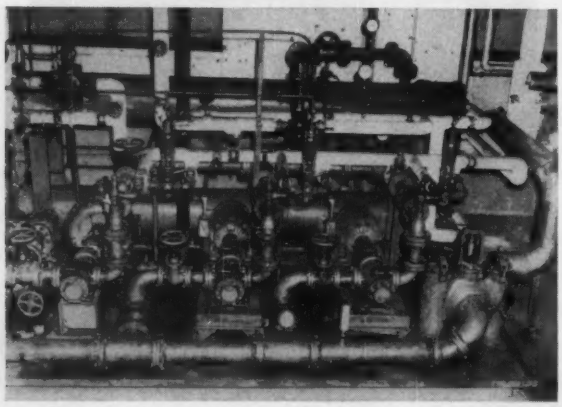
Turn page

Power MODERNIZATION PROGRAM

A 1955 AWARD WINNER



UNDERGROUND DAY TANKS hold 20,000 gallons each. During routine operation, oil is unloaded direct into these tanks



OIL PUMPING AND HEATING UNIT includes one turbine- and two electric-driven pumps, plus two tube-bundle-type heaters

POWERHOUSE OPERATION was uninterrupted during changeover from coal to oil. The plant steam demands had to be met

But world conditions often have a strong effect on oil prices, and this was not a prime factor in justifying conversion.

Original prediction: For the first three years of operation, price of bunker-C oil would not be above coal parity; afterwards, savings in labor and maintenance would more than offset potential oil-price increases.

Oil price has since gone up, and company engineers are now restudying the possibility of dual firing, with either gas or pulverized coal as the second fuel.

Converting to oil firing was expected to (1) cut the cost of maintaining fuel handling and firing facilities (2) practically eliminate fuel-handling labor costs (3) increase boiler thermal efficiency (4) increase electric-generating capacity.

Additional strong arguments were cleaner operation, reduced flyash and coal-storage elimination.

One big question was whether to fire oil over the existing stokers, or to remove the stokers and rely on a single fuel.

There are obvious advantages in being able to fire either oil or coal, depending on price. But Merck engineers finally decided to remove the stokers completely and install oil burners in a rebuilt firebox. Here's why: (1) With stokers removed, installation would be much more satisfactory both engineeringwise and operationwise (2) Continuing to rely partly on coal would mean little or no drop in cost of maintaining coal-handling equipment (3) Firing oil over even well-protected stokers for long periods might damage them, and operators could not rely on their condition. With the stokers removed, alternate firing facilities would have to be provided if an oil shortage developed.

A study of anticipated steam loads indicated that converting only the four large boilers would maintain firm capacity. The two smaller units could remain unchanged and continue to serve as coal standbys.

Starting the work. Plant-maintenance department made all installations, except erecting the large oil-storage tank and the boiler brickwork.

Powerhouse operation could not be interrupted, and work had to be scheduled so the chemical-plant steam demands were met. One boiler at a time was converted and tested, starting with the smaller low-pressure unit.

Stoker was removed, combustion chamber rebuilt, and a new boiler front installed. As conversion progressed, other crews installed two underground day tanks, put in pumping and heating equipment, added oil lines and controls.

POWER acknowledges cooperation of Edward Davison, chief, Engineering Utilities and Survey Section, and R B Pace, utility engineer, Merck & Co, Inc, Chemical Division, in furnishing information for this article.

First burner was lit at the end of March 1953. After engineers solved initial problems of control adjustment, proper burner tips and burner location, best method of lighting off, etc, operating crew was trained to run the unit. Then conversion of the three larger boilers proceeded.

Here is the thinking of Merck engineers on some of the conversion problems, and the final setup.

Oil storage. The big problem was deciding how much oil to keep in plant storage tanks. There had been enough coal storage for six to eight weeks' normal operation. But it is only 30 minutes driving time to several oil-storage depots. So it was finally decided to maintain a two to three weeks' oil supply at all times.

On this basis, one 500,000-gallon storage tank at the north end of the plant, 250 feet from the nearest manufacturing building, and two 20,000-gallon underground day tanks just outside the powerhouse were adequate.

Pumps move oil from day tanks to boilers. A 6-inch transfer line, 1500 feet long, connects the half-million gallon tank with the day tanks. Pumping stations at both ends of the line permit transferring oil either way. And oil can be unloaded at both points from tank trucks or rail cars.

For routine operation, oil is trucked in and unloaded directly into the day tanks. The large storage tank is kept full and maintained as an emergency supply, except for some use on weekends.

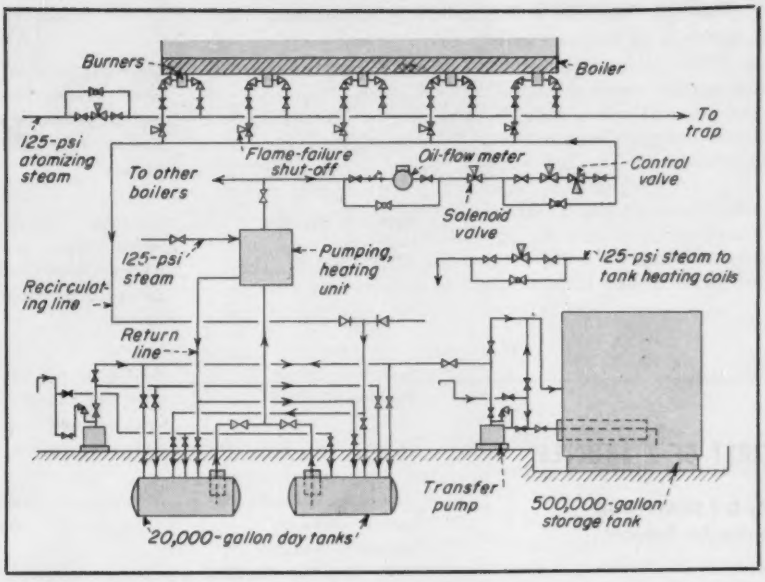
Pumping 10,000 to 20,000 gallons of oil out of the storage tank over the weekend eliminates Sunday deliveries.

Heat for the tanks and transfer line comes from the 125-psig steam header. Each day tank is heated by a vertical coil that can be removed without emptying the oil. A 2-inch steam line, directly beneath the 6-inch transfer line, acts as a steam tracer and supplies steam to the suction heater outside the storage tank.

There are no heating elements inside the storage tank, except a small pancake steam coil for emergencies. If it is ever needed, this will be connected to a portable steam line. Not having a regular heating coil inside the tank eliminates danger of a steam leak.

Piping at the transfer pumps permits recirculation while oil heats up to pumping temperature.

Oil pumping and heating. There are one turbine- and two electric-driven positive-displacement oil pumps. Any one of them could handle the plant's summer steam load. The turbine-driven pump or the two motor-driven pumps handle maximum anticipated winter demand. Normal operation is with the motor-driven units. Turbine-driven pump automatically takes over if oil pressure drops below a set point.



FLOW DIAGRAM shows how the fuel oil is delivered from storage tanks to burners; 125-psi steam warms oil lines, supplies heaters in the pumping and heating unit

There are two tube-bundle-type oil heaters, sized so either can handle maximum demand. Additional features of the pumping and heating equipment include duplex suction and discharge strainers, automatic control of temperature at heater discharge and oil pressure at pump discharge. Piping arrangements permit bypassing any portion of the equipment for repairs without an overall shutdown.

At design conditions, installation supplies up to 80 gpm to the boilers at 220 F, 150 psig. Controls can be adjusted up to 400 psig if necessary.

Burners, combustion controls. To simplify maintenance and operation, Y-jet steam-atomizing burners are used for all boilers.

The two newer high-pressure units had complete combustion-control systems for coal operation. Modification for oil firing was relatively easy. Principal change: substituting oil-flow controls for the stoker speed control.

The oil-control valve is connected to the boiler master control, and thus feels load changes. The f-d fan, in turn, follows fuel-flow variations, and the i-d fan control is tied to furnace pressure.

The two older low-pressure boilers had operated with manual combustion and feedwater control. They had individual f-d fans and individual dampers.

Their new control system has one master, receiving impulses from the main steam header and controlling fuel to either, or both, boilers. F-d fan controls follow fuel-flow variations and stack damper control is tied directly to furnace pressure.

The new installation also boasts a single-element feedwater control for each low-pressure boiler, and pressure-control valves on the reciprocating feedwater pump.

Safety devices installed are: (1) a purge cycle system that at startup prevents oil flow to the burners until the boiler has been purged by a measurable air flow for a specified time. This assures a gasfree boiler at initial light-off. Tied in with this system is a mechanism to shut off oil if either f-d or i-d fan fails. (2) a flame-failure device for each burner. This device has generally been adopted for smaller packaged boilers, which often operate without trained supervision. But it has not been generally accepted for large attended industrial boilers.

It was a problem to locate each device properly and at the right angle so it "sees" only the burner it is supposed to supervise. But this has been solved successfully. If flame goes out in any one burner, safeguard shuts off the oil valve feeding it. This prevents spraying liquid oil through an unlit burner. Such an accident could result in oil lighting off from the walls or an adjacent burner. This might be the cause of a damaging furnace explosion.

Internal water treatments... how they work

Internal chemical treatment	Purpose	Design and layout tips
Sodium-sulfite injection	Scavenges residual dissolved oxygen, prevents pitting of feedwater lines, pumps, economizers, boilers	Inject as far as possible from boiler. Usually added in deaerator storage tank or feed line following heater
Hydrazine injection	Scavenges residual dissolved oxygen, prevents pitting of feedwater lines, pumps, economizers, boilers	Precise feeding necessary. Overfeeding liberates free ammonia, corrodes brass or bronze fittings, heat-exchanger tubes
Sodium-phosphate injection	Precipitates residual calcium and magnesium as insoluble salts that can be removed by blowdown	Most commonly injected direct to boiler by constant-speed chemical feed pumps
Add excess of caustic soda to sulfite or phosphate feed	Maintains right feedwater pH to prevent corrosion	Part of sulfite or phosphate systems. May be separate on large installations
Add filming or neutralizing amines direct to boiler or steam lines	Prevents carbon-dioxide corrosion	Neutralizing amines raise condensate pH. Filming amines plate out condenser and return-line surfaces

FIRST OF 2 ARTICLES

By G E SHAFFER JR
Milton Roy Company

Which chemical-pump system for your plant?

There is no pat answer. But your water-treating specialist can put you on the right track in deciding on how much chemical solution to use—and how to add it

► BEST PIECE of advice in planning a chemical-feed system for your plant: Check with a water-treating specialist and you'll be well on the road to choosing the right system. In pinning down final choice he'll weigh the pros and cons of an array of systems from simple shot-feed to completely automatic.

Table, at top, and the following sections, brief the common internal treating methods, highlight pumping systems. While they aren't specific recommendations for your plant, they show some of the ways that controlled-volume pumps meter chemicals.

● **Oxygen scavenging** prevents pitting of feedwater lines, pumps, economizers, boilers. Deaerating heaters remove biggest part of dissolved oxygen. But a small quantity of residual O_2 remains, is scavenged with sodium sulfite. Sulfite chemical solution reacts slowly with dissolved O_2, so it's smart to inject the solution into boiler-feed line as far away from the boiler as possible. Good injection point is the deaerator storage tank or feed line leaving the tank.

About 10 parts sodium sulfite react with dissolved O_2, yield a slight excess of sulfite in the boiler water.

● **If hydrazine is used** to scavenge residual oxygen, precise chemical feeding is a must. Overfeeding liberates free ammonia, corrodes brass or bronze fittings and heat exchangers.

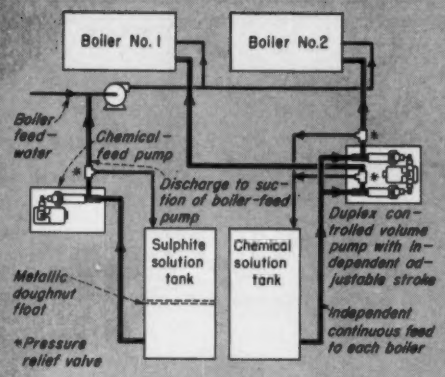
Hydrazine is stable in usual concentrations needed for O_2 scavenging systems. The 3 to 5% solutions injected into boiler feedwater retain their activity for weeks. And at the normal residual hydrazine concentration in the boiler—.05 to .25 ppm—there's no tendency to decompose.

● **Residual calcium** in feedwater precipitates as an insoluble sludge when it reacts with sodium phosphate. In effect, internal phosphate treatment prevents formation of calcium sulfate, a salt that adheres to boiler surfaces, forms scale. Periodic blowdown removes the insoluble sludge.

● **Maintaining boiler-water pH** at right level can't be overlooked if you want hardness removal reactions to take place. Smaller installations get good pH control by adding an excess of caustic soda to either the sodium sulfite or the phosphate feed. On big jobs, where precise control is a must, separate pH control systems hold the right alkalinity level with minimum supervision.

● **CO_2 corrosion.** Carbonates and bicarbonates in feedwater can form solutions at boiler-water temperatures, releasing carbon dioxide to steam. Resulting carbonic acid pits and corrodes condensers, condensate-return lines.

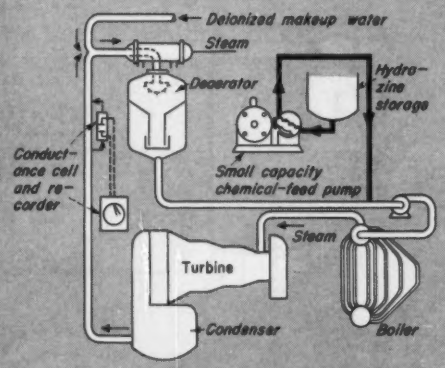
Neutralizing amines raise condensate pH, reducing corrosion. Filming amines plate out on condenser and condensate return lines, insulating these surfaces against acid corrosive attack.



For sulfite, phosphate . . . a packaged system

Sulfite, phosphate injection can be handled by a packaged system like the one at left. Here, the chemical-feed pump injects sulfite directly into the deaerating-heater storage tank or into the tank's outlet line. Feeding sulfite into the feedwater system well ahead of boilers assures complete oxygen scavenging before water reaches boilers. A duplex-type pump meters phosphate to each boiler drum.

The complete system includes tanks, pumps, relief valves and a doughnut float that keeps air from reacting prematurely with the sulfite solution. A low-level alarm on each tank warns operator when new chemical charge is needed. Alarm makes sure feed isn't interrupted.

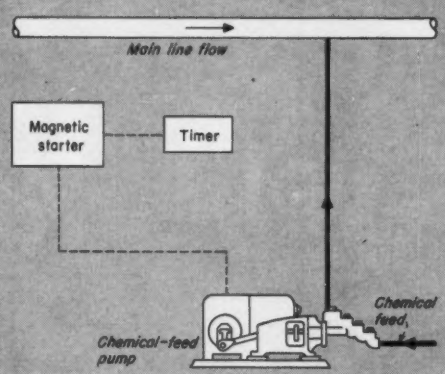


For hydrazine . . . a small-capacity feeder

We've already seen that overfeeding hydrazine to scavenge dissolved oxygen liberates free ammonia. So accurately controlled hydrazine injection is important.

If you're going to consider an automatic system, condensate conductivity measurement does a good job. Hydrazine feed-rate dip shows up in control system as reduced condensate conductance.

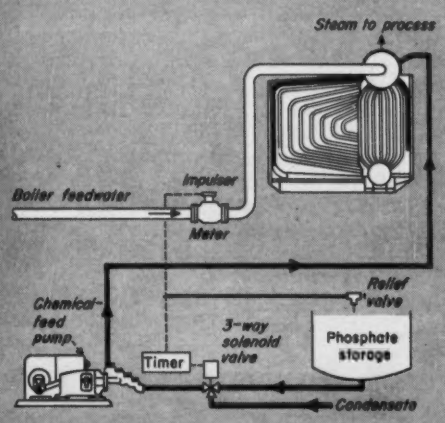
Small quantity of hydrazine additive (.005 to .030 ppm) needs a small-capacity controlled-volume pump to act as the final control element. Pump at left accurately meters from zero to 225 milliliters of 3% hydrazine solution to feedwater. Analyzing water periodically for residual hydrazine or measuring conductivity on a continuous basis serves as a check on hydrazine feed rate.



For constant flow rate . . . an elapsed time cycle

If feedwater flow is relatively constant you can set a timer to operate the metering pump intermittently during a repeating time cycle. Set pump capacity manually to deliver (during part of cycle when it's pumping) chemical needed to treat total water volume for the complete time cycle.

If needed chemical dosage conditions change, manually reset pump delivery rate or change chemical solution's concentration. To be sure of a constant ratio between chemical injection and feedwater over a number of cycles, follow the cycle with a retention period.



For varying flow rate . . . an elapsed flow cycle

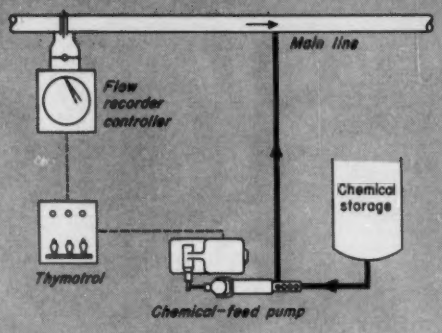
An integrating flowmeter can act as the measuring element to get proportional feed where water flow rate varies. Electrical impulse from the meter energizes a timer, starting the chemical feed cycle. The controlled-volume pump operates for a fixed time on each contact.

In a variation of this simple setup, the timer receives an impulse from the meter and starts a feed cycle by turning the 3-way valve, left, to feed position. The pump operates continuously. For first part of cycle the pump meters phosphate solution to the boiler. For a preset balance of the cycle, the timer deenergizes the 3-way valve, directing flushing water (condensate or softened water) through the pump and chemical feed lines.

(Turn page)

Proportional feed . . . with electronic control

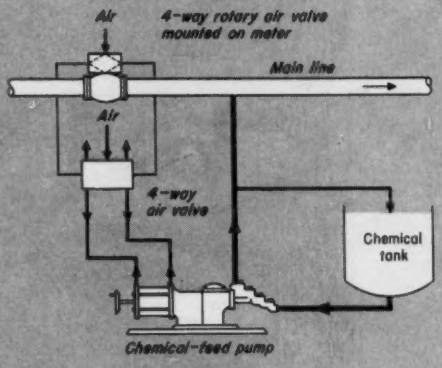
Pump-speed regulation adjusts chemical feed rate in proportion to main-line flow changes. In the setup at right a flowmeter measures main-line flow rate, positions a 10,000-ohm potentiometer that's built into the meter. Potentiometer signal adjusts the Thymotrol setting, automatically varying pump-motor speed. Chemical feed follows motor speed. So the pump operates continuously, instantly changing chemical injection rate in direct proportion to water flow rate.



Proportional feed . . . with pneumatic control

The air-operated system at right does much the same job as the electronic system, above. Meter in main flow line can be either positive displacement or velocity measuring type. Either one can translate the measured variable (either a volume or a velocity) into a rotary output shaft movement. A 4-way rotary air-pilot valve sends an air impulse twice each revolution to a master 4-way valve. Piston in the master valve reciprocates with each pulse, admitting air first to one side of the pump's air cylinder, then the other. Chemical injection thus follows main line flow as measured by the meter.

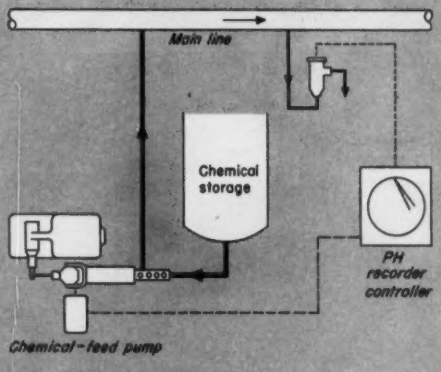
Here's an example: Rotary air valve's shaft could be geared to make one revolution for each 2-gpm main flow. At 50 gpm, shaft would complete 25 rpm, stroking the pump 50 times a minute. If main flow dips to 25 gpm, pump strokes 25 times a minute.



Automatic pH control . . . a versatile tool

By imposing close limits on pH we stand to make several important gains: (1) Corrosion or scale prevention is tied directly to pH control. (2) Various coagulants—alum, ferric chloride, ferric sulfate, sodium aluminate—work best at definite pH ranges, depending on other materials present in the water. (3) pH control insures neutralizing of zeolite-treated water for process use.

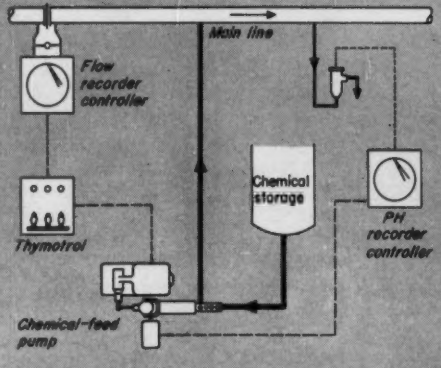
In the automatic pH-control system, right, we're measuring a variable (pH) that depends on the reaction between added chemical and the raw liquid. A closed-loop control system uses a chemical metering pump as the final control element. Line flow rate is constant in the system shown. The pH controller sends an electrical signal to pump's motorized stroke adjuster that depends on deviations from the pH control point. Automatic stroke control thus holds pH within close limits.

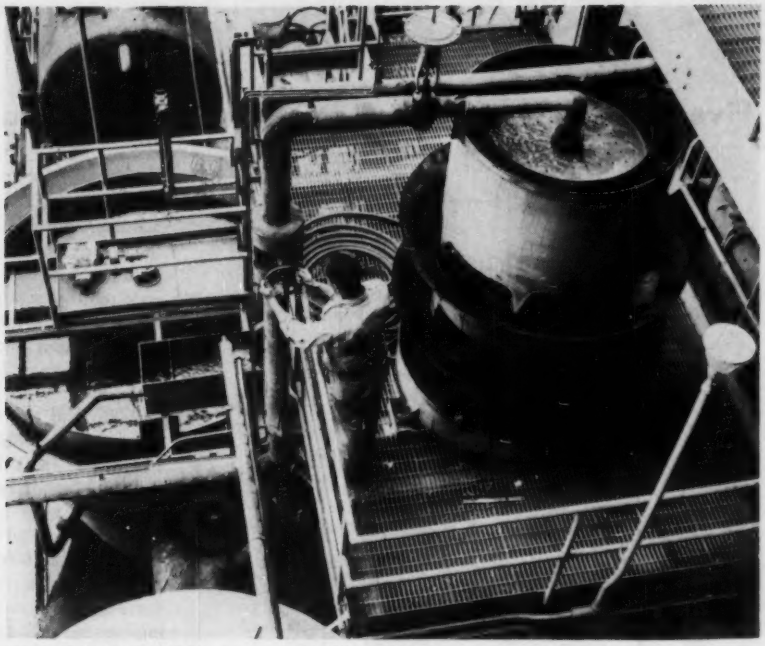


For big-load swings . . . combined pH, flow control

If main-line flow is subject to wide load swings, it pays to use both pH and flow as control-signal sources. The system at right electronically regulates pumping speed, through a Thymotrol unit, in direct proportion to flow. The pH controller automatically adjusts pump-stroke length. Combined setup allows the pump to handle required chemical variations as great as 100 to 1.

Same system also works on air. A rotary air valve mounted on a nutating-disk water meter regulates pump speed. And a pneumatic pH controller replaces the electronic controller, adjusts pump stroke length through an air-piston operator.





COKE-TRAY AERATOR, capacity 86,000 gpd, helps remove 5.0 ppm Fe from well water

Supplying suitable water for process operations is one of the big problems power service engineers face today. Here, in the first of two articles, a well-known authority tells . . .

By **ESKEL NORDELL**
The Permutit Company

How to remove iron and manganese from industrial process water

► Two of the most troublesome elements met in industrial water supplies are iron and manganese. Iron is fairly common, being found in one form or another in a large number of waters. Manganese, fortunately, is much rarer. Only a few iron-bearing waters contain manganese and there are few waters containing manganese alone.

Process-water troubles caused by these elements can be expensive and wasteful. Iron and manganese contaminate everything they contact, producing ugly, insoluble rusty-brown, yellow, gray or black stains, blotches and streaks. Iron usually produces yellowish-brown to reddish-brown stains, while manganese causes gray to black stains. But iron, in contact with certain substances like tannin, may also form gray to black stains.

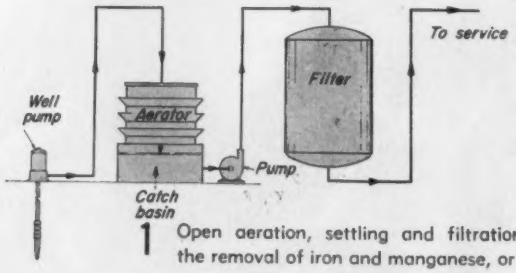
Besides forming adherent deposits, iron and manganese can form insoluble suspended precipitates. Waters bearing these elements also favor the growth of iron and manganese bacteria, known as Crenothrix. These are aerobic—they need some air to flourish but, given that, they thrive in the dark or the light. So they grow well in tanks and pipes, forming luxuriant linings. These cut flow rates and often break loose in large masses, clogging nozzles, recirculating systems, pumps, etc. Decaying masses impart bad tastes and odors to water.

Tolerances. Because of these extremely undesirable properties, iron- and manganese-bearing waters are unsuitable for almost all industrial wet-processing operations. These waters should be treated *before use* to meet the following tolerances: For high-grade products—iron, not over 0.1 ppm as Fe; manganese, not over 0.05 ppm as Mn. For lower grade products—iron, not over 0.3 ppm as Fe; manganese, not over 0.1 ppm as Mn.

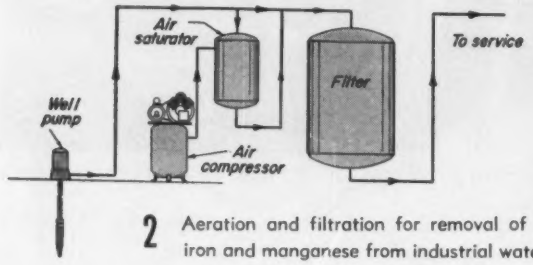
Iron and manganese forms. In iron-bearing waters the iron may occur in one or more of four forms:

1. In clear colorless nonacid ground waters iron occurs as ferrous bicarbonate. This is a soluble colorless salt existing only in solution. When freshly drawn these waters are clear and colorless. But on standing in contact with air, they first

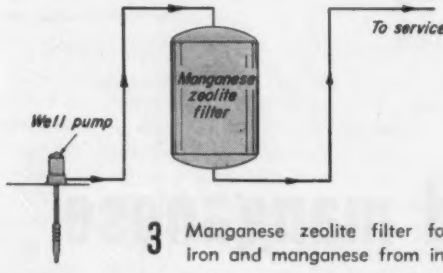
Five popular methods for removing iron and manganese from water



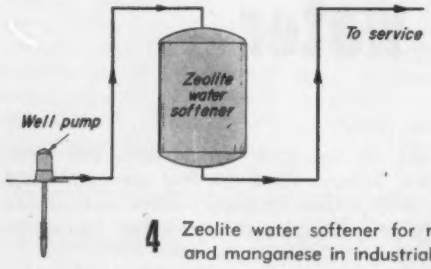
1 Open aeration, settling and filtration for the removal of iron and manganese, or both



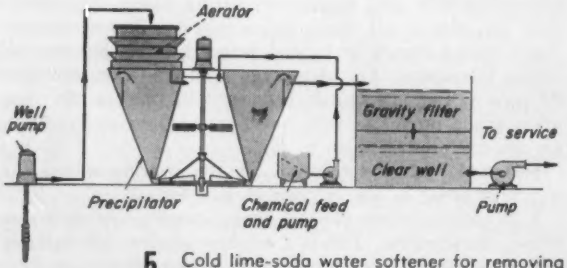
2 Aeration and filtration for removal of the iron and manganese from industrial waters



3 Manganese zeolite filter for removal of iron and manganese from industrial water



4 Zeolite water softener for removal of iron and manganese in industrial water supplies



5 Cold lime-soda water softener for removing iron and manganese from industrial water

develop a whitish haze, which then turns to a yellowish or reddish-brown color as the colorless soluble ferrous bicarbonate oxidizes to form the highly colored insoluble ferric hydroxide. Some of this sticks to the walls of the vessel holding the water, while some may deposit on the bottom. Depending on the pH and degree of aeration of the water, this oxidation may take less than 15 min, or several hours, for completion. Effect of pH is fully discussed later in this article.

2. In acid surface waters, part or all of the iron may be present as soluble ferrous sulfate. This is a light green salt but, at the great dilutions present, the color is not noticeable. In some acid surface waters, suspended insoluble ferric hydroxide may also be present. Acid ground waters are usually clear and free of suspended matter; the iron may all be present as ferrous sulfate or part may be present as this, and part as ferrous bicarbonate. Often acid waters, both surface and ground, also contain manganous sulfate, aluminum sulfate and, except those containing some ferrous bicarbonate, varying amounts of sulfuric acid. Also, with this same exception, acid waters generally do not cloud and deposit iron on exposure to the air unless they are first neutralized.

3. Color of water is due to organic material extracted from decaying vegetation. High-color surface waters usually originate in swampy areas, while high-color well waters are usually found under overlying layers of peat. Many high-color waters contain iron in organic or chelate form. When so held, iron does not precipitate when aerated.

4. Red waters owe their reddish-brown appearance to suspended insoluble ferric hydroxide. They usually result from the action of corrosive waters containing dissolved oxygen on the ferrous metal of mains, piping or tanks. They may also be due to ground waters containing ferrous bicarbonate, which receive aeration from air-lift pumps, pneumatic storage tanks or open tanks, basins or elevated storage tanks.

In various manganese-bearing waters, manganese, with one exception, may occur in much the same forms as iron. (1) In clear colorless alkaline ground waters it occurs as manganous bicarbonate. (2) In acid waters it occurs as manganous sulfate, usually in conjunction with ferrous sulfate and often also with aluminum sulfate. (3) In high-color water it occurs as chelate manganese. (4) The one exception, mentioned above, is that it seldom occurs as the suspended insoluble manganic hydroxide because it requires a higher pH to oxidize and precipitate it than is usually found in natural waters.

Removal of iron and manganese from process waters may be accomplished by one of six methods: (1) aeration, settling and filtration (2) manganese-zeolite process (3) zeolite water softening (4) cold lime-soda water softening (5) combination lime-zeolite water softening, and (6) hydrogen cation-exchanger and demineralization processes.

Methods 1 and 2 are for removing iron or manganese alone; 3, 4 and 5 are for both softening the water and removing iron and manganese. Method 6 is for removing calcium, magnesium and sodium, together with iron or manganese.

Aeration, settling and filtration remove both iron and manganese. But as manganese requires different conditions for its oxidation, the removal of ferrous bicarbonate will be considered first. While ferrous bicarbonate has appreciable

Table 1: Analyses of ten typical iron-bearing ground waters

Iron contained as ferrous bicarbonate

Location	Well or spring	Iron as ppm Fe	Water analysis, expressed as ppm $CaCO_3$				Carbon dioxide (ppm CO_2)	pH value
			Hardness	Bicarbonate	Sulfate	Chloride		
Alexandria, Va.	Well	2.5	30	7	16	6	45	5.5
Bartlett, Tex.	Well	2.0	270	406	458	600	31	7.4
Crawfordsville, Ind.	Spring	0.9	444	334	—	25	13	7.7
E. Lansing, Mich.	Well	1.0	320	308	36	6	23	7.4
Guilford, Conn.	Well	11.0	70	73	29	22	52	6.5
Lindale, Tex.	Well	1.8	57	115	16	13	1	8.3
New Bremen, Ohio	Well	3.5	490	228	397	13	30	7.2
St. Catherines, Ont., Can.	Spring	1.2	1480	78	1630	131	10	7.2
Selkirk, N. Y.	Well	1.8	310	283	58	9	42	7.1
Union City, Tenn.	Well	2.0	30	38	5	6	45	6.2

Table 2: Manganese-bearing waters—nine typical well waters, one lake water

Well waters are manganese—lake water manganous-bearing

Location	Manganese as Mn	Iron as ppm Fe	Water analysis, expressed as ppm $CaCO_3$				Carbon dioxide ppm CO_2	pH value
			Hardness	Bicarbonate	Sulfate	Chloride		
Cleveland, Ohio	0.8	1.5	244	136	80	82	55	6.7
Eureka, Calif.	0.8	0.3	215	25	101	189	70	5.9
Lake Jacksonville, Tex.	1.6	1.8	36	55	3	13	—	7.1
Longview, Wash.	1.5	5.0	154	176	3	13	36	6.9
Neville Island, Pa.	1.5	<0.1	235	38	253	27	16	6.7
Omar, W. Va.	3.6	15.0	524	31	688	9	50	6.2
Parkville, Mo.	1.0	18.0	728	677	85	65	165	6.9
Woburn, Mass.	2.0	1.2	164	21	174	66	19	6.3
Rockford, Ill.	0.4	0.4	286	260	17	21	30	7.2
Tuckerman, Ark.	1.3	3.4	139	151	10	3	19	7.2

solubility, ferric hydroxide has a solubility that is so low it is negligible. So on oxidizing ferrous bicarbonate to ferric hydroxide, the iron content of the water will be precipitated in almost an insoluble form. Oxidation is rapid and complete at pH values of 7.0 or higher. At somewhat lower pH, the oxidation proceeds at a much slower rate. If the pH of the water is below 7.0, it is advisable to raise it to assure complete oxidation and removal of the iron.

Fig. 1 shows a flow diagram of the aeration, settling and filtration process for removing iron or manganese, or both. Probably the most widely used aerator is the coke-tray type. Wood-slat tray and forced-draft aerators are also used. It is usual practice to provide a catch basin or settling basin under or alongside the aerator with a nominal detention period of 30 min or more. With water of favorable pH, this period may be as little as 15 min. But if the iron content is high, it is advisable to remove the bulk by settling. Basin should have a detention period of at least 1 hour. Filter effluent from this process has an iron content of not more than 0.1 ppm.

Manganous bicarbonate requires a pH above 10 for its oxidation unless ripened filters are used. With these a pH of 8.5 to 9.0 is sufficient. A disadvantage of ripened filters is that the manganese coatings on the filter media get so thick that pieces shell off and contaminate the effluent. Periodic treatments are necessary to dissolve the coatings before they become too thick.

Increasing the pH values for removing either iron or manganese is usually accomplished with lime, added following the aeration. Caustic soda may also be used, and for iron, soda ash.

Pressure aeration, followed by pressure filters, Fig. 2, is sometimes used with iron-bearing waters having small iron and free carbon-dioxide contents. Usually not more than 25% of the water is saturated under pressure with air. This shunted portion is then mixed with the main stream. This avoids spattering the water when it is drawn.

Chlorine is sometimes used to oxidize ferrous bicarbonate. It oxidizes iron at a much lower pH than air. Chlorine consumption is 0.64 ppm per ppm of iron, expressed as Fe, present. Chlorine is of little or no value in oxidizing manganese.

Manganese-zeolite process removes iron or manganese by filtering the process water through a manganese-zeolite filter. The zeolite used is made by treating a sodium zeolite with manganous sulfate and potassium permanganate. The higher oxides of manganese are deposited on the granules of zeolite. In this state it oxidizes the ferrous bicarbonate or manganous bicarbonate content to higher insoluble hydrated oxides, which are then removed by the filtering action of the manganese zeolite bed. After its oxidizing powers are exhausted, it is regenerated with potassium permanganate, which restores it to its active condition.

(*Continued on page* 212)

MINERAL-WOOL-BLOCK thickness equals stiffener width, prevents waste, avoids need to shape outer blocks. Tie wires, fastened to duct clips, hold mesh and blocks

ROUGH SURFACE of first coat of insulating cement gives bond with second

Prevention of expansion cracks,

heat barriers built around stiffeners are features of . . .

Insulation procedure for high-

► INSULATING high-temperature ductwork poses three particular problems: (1) Protruding members, like flanges and stiffeners, are obstructions, interfere with application of insulation. (2) Obstructions in contact with duct plates are paths of heat loss and must be insulated. (3) Duct expansion cracks in the insulation must be prevented.

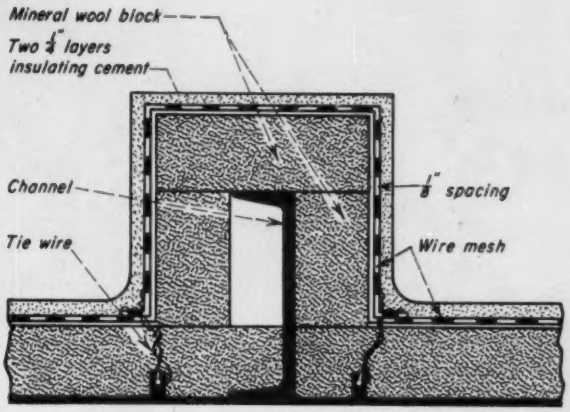
Insulation contractors licked these problems at Ford's River Rouge Power House No. 1. They selected, as basic material, a mineral-wool block made by Baldwin-Hill Company of Trenton, N. J. Blocks are light weight, easy to shape and install, make an effective heat barrier. Combining right material with method know-how produced an efficient, economical installation.

Correct choice of block thickness minimized the disruptive effect of flanges and stiffeners. Two-in. thickness would give enough thermal insulation, but 3-in. would bring block surface flush with edge of most stiffeners. The 3-in. simplified both application to flat surfaces and addition of material to completely cover the stiffeners. At points where basic insulation was not thick enough to cover stiffeners, job specifications called for an additional layer of block. Thickness had to be 1½ in., or thickness of basic insulation less 1 in., using the lesser dimension.

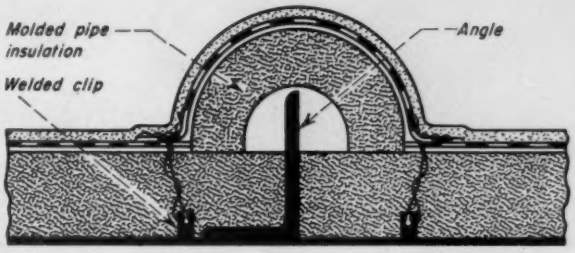
Clips welded to duct surfaces held 14-gage annealed steel tie wires. The wires, pulled through blocks, were laced through 20-gage 1-in. wire mesh laid over the blocks. All block joints were staggered, buttered and pointed with mineral-wool insulating cement. Double-layer area joints were staggered with respect to both block and layer. Again, using block thickness equal to stiffener height paid off. Top layer didn't have to be shaped to cross stiffeners, which saved time, avoided waste.

Fig. 1 shows insulation of a large channel. Two pieces of 3-in.-thick block are cut so their width equals distance channel extends from surface of basic

Setup for topnotch thermal seal

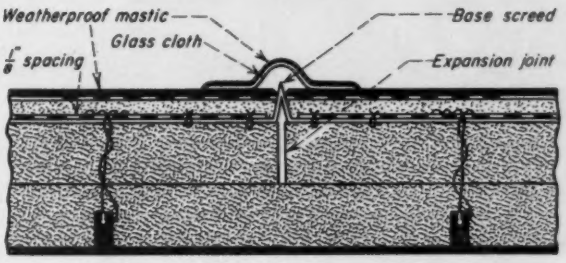


1. Large channel extending from duct plate



2. Angle extending beyond block thickness

3. Stiffener height equal to block thickness



4. Base screed installation for expansion joint

temperature gas and air ductwork

layer. These support a third block of predetermined thickness. A run of wire mesh is laid over the assembly. Tie wires coming through from the basic course mesh tie both courses of mesh together. Note that both courses are raised about ⅛ in. from their respective block surfaces, to provide a key for the first layer of insulating cement.

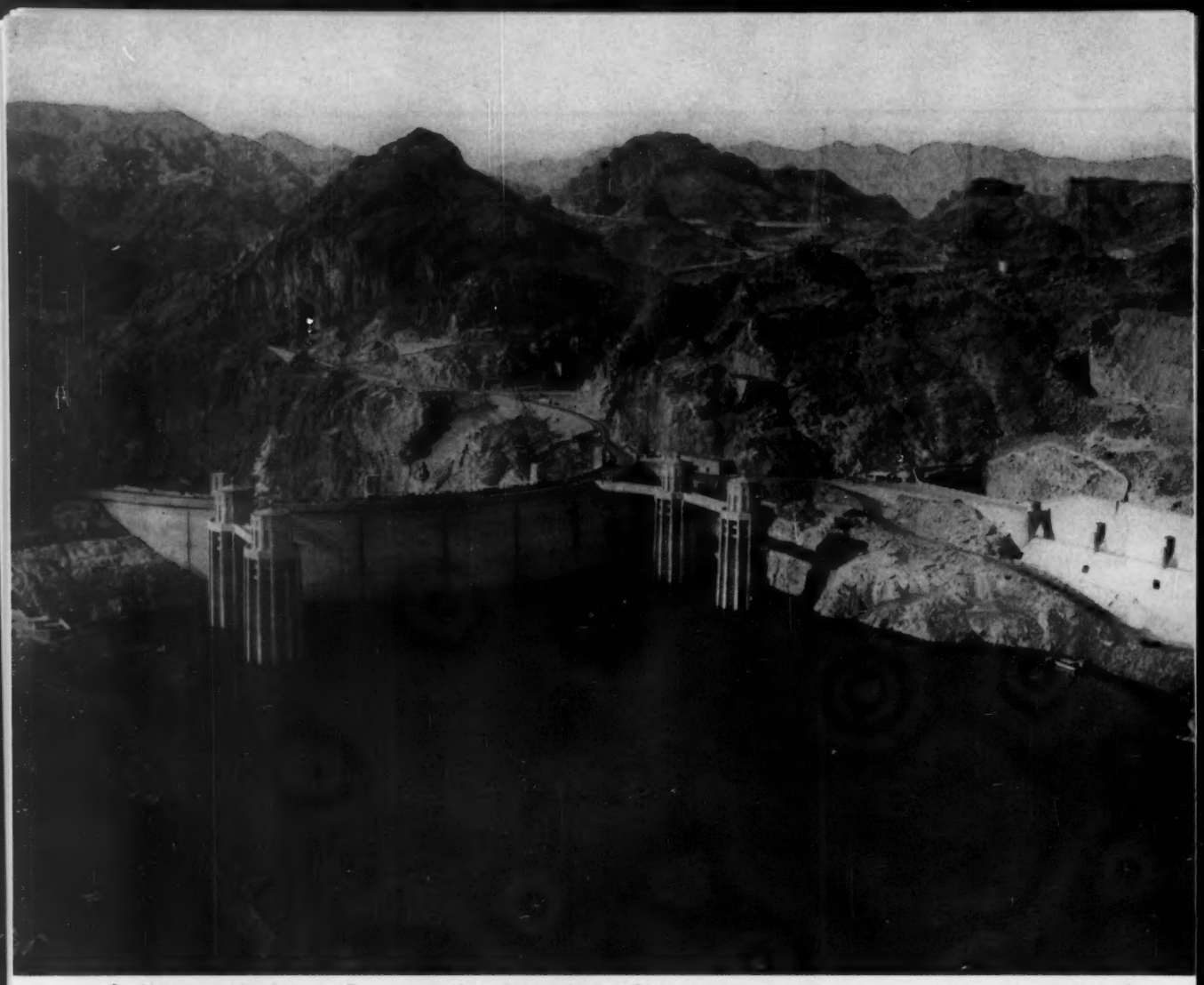
Fig. 2 shows insulation of an angle protruding beyond the basic layer of block. Here, instead of a block, a half-section of molded mineral-wool pipe insulation centers over the protruding member. Courses of wire mesh, tie wires and insulating cement complete the joint, as in Fig. 1.

Fig. 3 shows method used when stiffener height didn't exceed basic layer. Three-in.-thick block comes flush with edge of stiffener. A cover block, 1½ in. thick, 6 in. wide, centers over the flange. Finish of joint is similar to others.

Fig. 4 shows how expansion joints, installed in the cement, prevent surface cracks. Joint is made up of a base screed, wired to mesh holding block insulation in place. Screeds run longitudinally with mesh, are about eight feet apart. Edges of mesh must lap edges of screed, are not tied together except through screed. Extremely wide ducts also have lateral screeds on 8-ft centers, cutting longitudinal mesh runs.

Duct corners have corner beads laced to the wire mesh. All insulation, including joints, has first ¼-in. layer of insulating cement keyed into wire mesh. Surface is rough-finished to form bond with second layer, of equal thickness, troweled to a smooth finish.

A ½-in.-thick layer of asphaltic mastic material protects all surfaces exposed to weather. Expansion joints get additional protection. Following application of the mastic, a section of glass fabric, bulged to allow for expansion, is pressed into the mastic. A final ¼-in. coat of mastic over the glass cloth completes the job, producing a weatherproof, lasting, thermally sealed joint.



1 Upstream side of Hoover Dam as seen from Arizona bank of Black Canyon. Four intake towers each feed a separate 30-ft-diameter penstock system running to plant at foot of dam and to the four outlet works a short distance downstream

Hoover Dam intake gates altered for

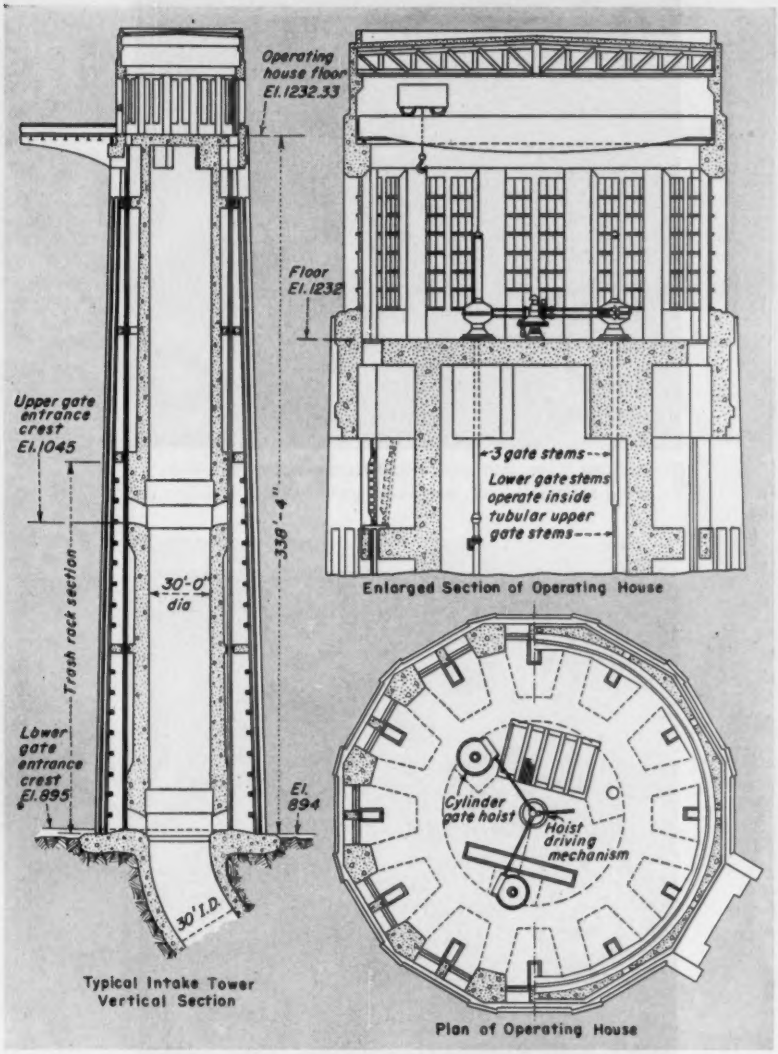
To be ready for an operating crisis that could possibly happen, the lower cylinder gates of the hydro plant's water intakes have been modified. Mathematical studies, laboratory-model tests and full-scale tests preceded the decision to alter gate design*

► WATER FROM LAKE MEAD behind Hoover Dam enters the four penstock systems through four intake towers. The 30-ft-diameter penstocks lead to the 17 turbines in the two plants and to 24 needle valves controlling the outlet works downstream from the dam.

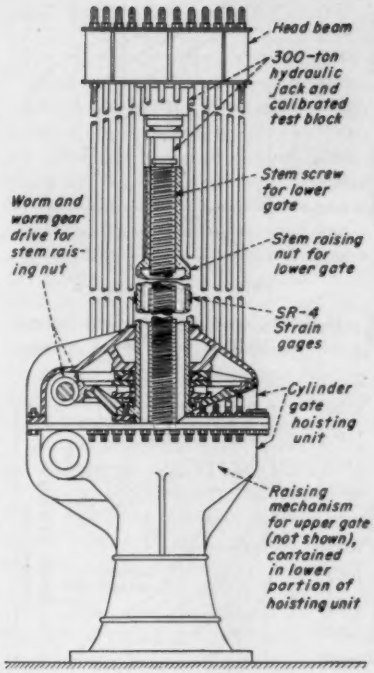
Each intake tower has two cylinder gates, 32 ft diameter, 11 ft high, 14 in. thick, one at the base (elevation 895) and the other at elevation 1045, Fig. 2. Inlet water from Lake Mead passes through these gates. Closing both gates in a tower unwaters the tower, penstocks, turbines, needle valves and other connected equipment for inspection and maintenance. With the head water at normal high level of elevation 1229, head on the lower tower gates equals 334 ft.

Original design of the intakes assumed the tower gates would be opened and closed under balanced water conditions—there would be no flow through the penstock during gate operation. But

*Abstracted from paper "Laboratory and prototype tests . . . of excessive downpull forces of large cylinder gates under high heads," by H M Martin and J W Ball, Bureau of Reclamation, Denver, Colo. Presented at Sixth Congress of International Association for Hydraulic Research, Delft, Netherlands.



2 Intake tower has two cylinder gates, one at bottom, the other 150 ft above, run by hoist mechanisms at top through stems. Lower-gate stems pass through tubes


Head beam
300-ton hydraulic jack and calibrated test block
Stem screw for lower gate
Worm and worm gear drive for stem raising nut
Stem raising nut for lower gate
SR-4 Strain gages
Cylinder gate hoisting unit
Raising mechanism for upper gate (not shown), contained in lower portion of hoisting unit

3 Cylinder gate hoist was rigged up to calibrate strain gages on the nut

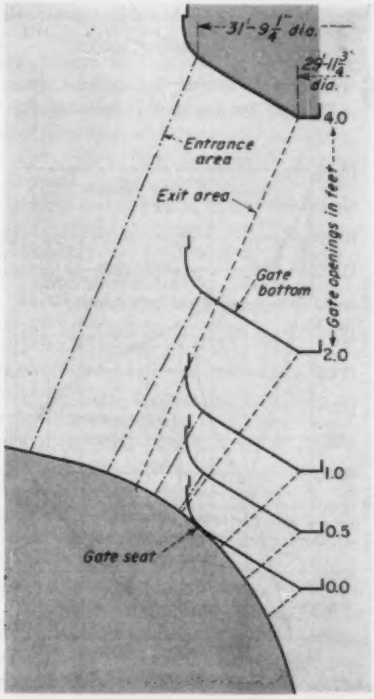
emergency closing

a needle valve might jam wide open or the penstock might break. In such emergencies, water level in the tower would drop and the higher pressure of the reservoir water would develop an inward radial thrust on the outer cylinder-gate surfaces.

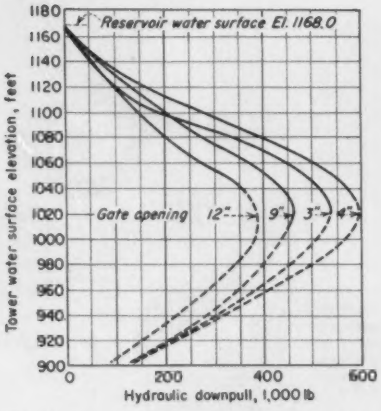
The gates can withstand this pressure rise. But the water, rushing into the tower underneath the gate while it closes, causes a venturi effect. Rising flow rate lowers the water pressure under the gate bottom. This causes a hydraulic downpull force on the gate. The 330,000-lb gate is operated by a 500,000-lb hoist. So if the downpull exceeded 170,000 lb, the hoist would be overloaded. Experience with other gates led Bureau of Reclamation engineers to believe that the downpull would be much greater than the 170,000-lb margin.

Investigation. Each gate is operated by a hoist through three stems, Fig. 2. Each stem was designed with pins to hold 413,000 lb. Inspection showed no signs of corrosion on the pins so it was assumed they could withstand the design force.

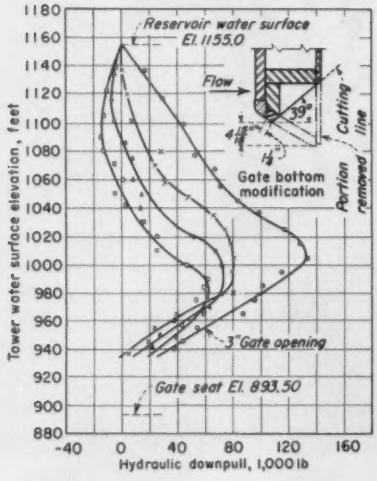
First step was a mathematical study



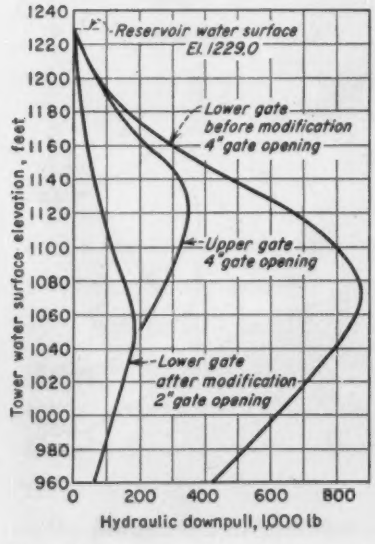
4 Water-flow entrance-and-exit area ratio varies as cylinder gate rises



5 Hydraulic downpull force was highest at the 1020-ft level, 4-in. opening



6 Cutting off bottom of cylinder gate reduced the downpull to less than ¼


Reservoir water surface El. 1229.0
Lower gate before modification 4" gate opening
Upper gate 4" gate opening
Lower gate after modification 2" gate opening
Tower water surface elevation, feet
Hydraulic downpull, 1,000 lb

7 Corrected to full reservoir level, curves compare effect of gate cut

8 Looking down into intake tower from upper-gate level we see a temporary roof, over lower gate, to keep workmen dry

9 Working platform used to cut off bottom of cylinder gate consisted of 24 prefabricated sections bolted to the gate

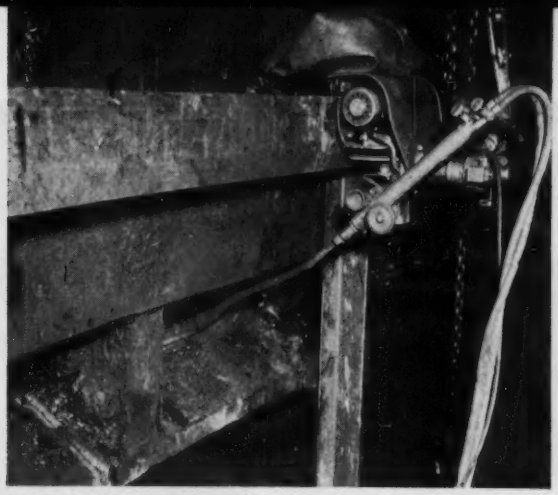
of the forces acting on the gates for various openings, water levels and penstock flows to find what changes in the gate operating equipment might be needed. This study was based on the upper gate being shut tight while the lower gate was slowly closing — and with the reservoir at elevation 1200. Water flows of 5,000, 10,000, 20,000 and 40,000 sec-ft were figured.

Fig. 4 shows the change in exit and entrance areas with gate opening. Up to about 1.75-ft gate opening, the exit area is greater than the entrance area. For larger openings the reverse holds true.

Cavitation pressures, as well as the separation of inlet-water flow from the boundary of the gate bottom, were expected to occur. Both of these factors change with differential head and gate opening. A point of separation near the upstream edge of the gate bottom would produce only a small downpull force; but separation farther downstream would increase the down-pull noticeably.

The study showed that with large discharges through the tower the downpull might be as high as 600,000 to 900,000 lb, depending on gate opening. This magnitude nears the capacity of the gate stems. Because of the many variables and assumptions that had to be made, the study could not be considered conclusive.

Second step. Hydraulic model tests were the next step in the investigation. Model of the intake tower built to a scale of 1:24 was nearly 18 ft tall and



10 Oxweld machine, mounted on guide rail, first cut off lower end of skin plate; here it is cutting off gate bottom

11 Gate-bottom segment flange, cut through by cutting machine, will be cut from rib by a finishing hand operation

had cylinder gates 0.583 in. thick. It was the largest model that could be installed in the laboratory. Analysis showed that downpull forces indicated by the model would not be as great as might be expected in the full-scale tower.

It was realized that the model might serve only as a necessary step in working toward the solution and that additional special tests might be needed. The model would help to show nature of the flow, the operating conditions giving maximum downpull, and whether similarity existed between model and full-scale tower.

Strain gages measured the downpull forces on the model, but severe vibration at small openings, when the downpull was a maximum, forced the use of another method of measurement. Piezometer connections in the model gate established the pressure distribution over the bottom. From this the total downpull on the gate could be calculated.

The model tests indicated: (1) a maximum downpull of 650,000 lb for a 6-in. gate opening (2) flow separation from gate bottom only, when gate was nearly closed (3) cavitation occurred on gate bottom for openings up to 1.5 ft under differential heads greater than 150 ft. Study of the model data showed that actual forces would be greater than calculated from the tests.

Certain limits of downpull forces to be expected in the full-scale tower could be estimated from the model data. These lay between 650,000 and 1,250,000 lb. The latter force would be developed if water vapor covered the entire sloping portion of the gate bottom. Assuming each of the three gate stems carried one-third of the load, it was figured the stem pins would be stressed to about yield strength in shear with a total downward force of 1,240,000 lb.

Third step. Tests were run on the lower gate in the upstream intake tower on the Arizona side of the canyon, nearest left-hand tower of Fig. 1. Strain gages of the SR-4 type were mounted on each of the three stem nuts to measure the strain induced under emergency gate closing, Fig. 3. Two gages on each nut placed diametrically opposite each other, connected in series electrically, operated as a unit. This arrangement eliminated any effects of bending that might act on the nuts during testing. Temperature compensation was provided by a set of two gages mounted on a manganese-bronze block (same composition as the stem nuts) at each stem.

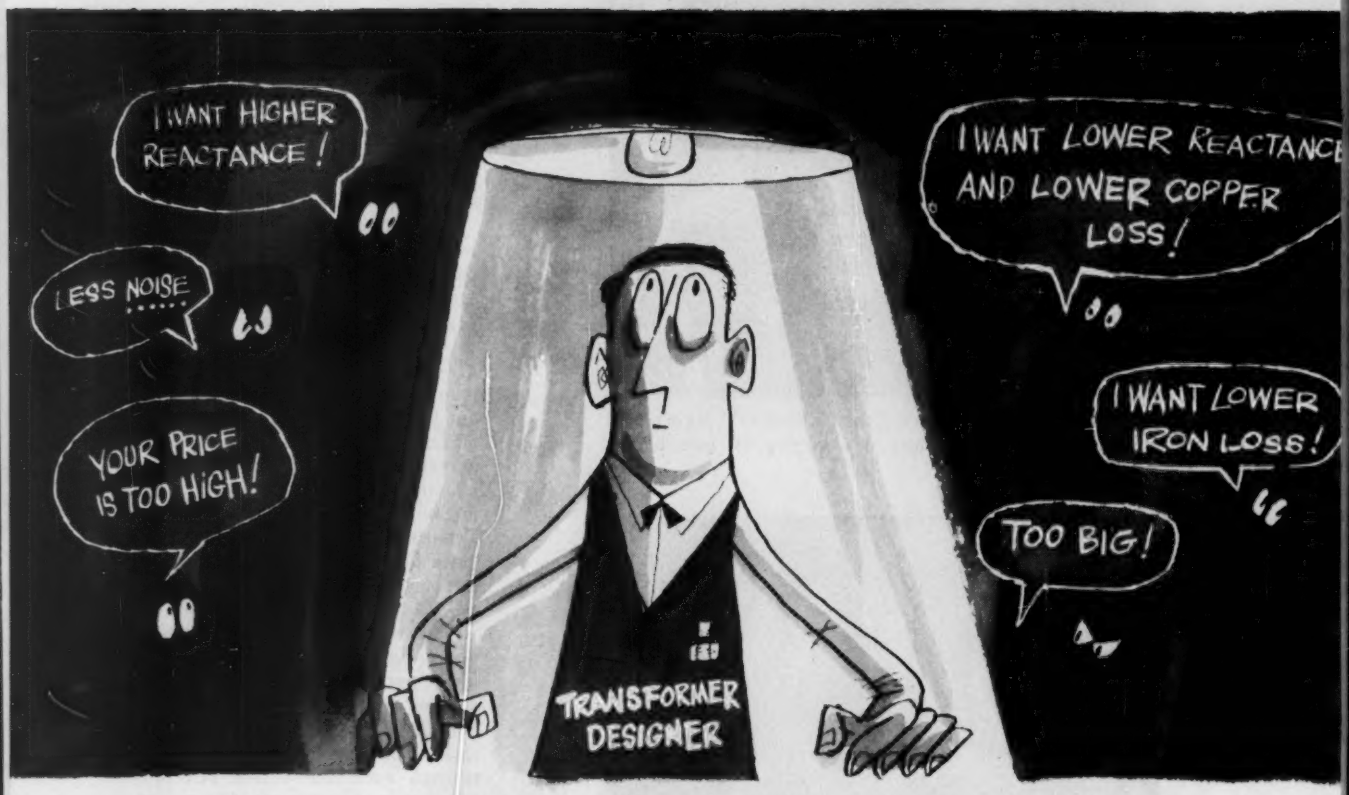
The strain gages were calibrated by the arrangement in Fig. 3. A cross-head beam, supported by long bolts on the gate-hoist-gear housing, in turn supported a 300-ton-capacity hydraulic jack. The jack applied known loads through a calibrated load cell to the stem screw. These loads were read and correlated with the strain-gage readings.

Full-scale tests were run with the upper gate closed. As the lower gate closes during an emergency the water level in the tower drops, the amount depending on the flow discharged from the penstock outlet. For each test the lower gate was set the given distance above the seat and then the tower water level lowered by operating the 72-in. needle valves in the penstock discharge outlet. Observers at several stations recorded their observations. Strain readings were taken with the tower water level at reservoir elevation of 1168, then at 1165, and at each 5-ft increment below 1165.

First test was run with a 3-in. gate opening, because maximum downpull was not expected with that setting. As the tower water level dropped to 1090, slight cavitation and vibration noise developed. At elevation 1058 the penstock inside the 50-ft tunnel made an intense noise at the bottom of the tower, but there seemed to be no motion of the pipe other than slight cavitation shock. Noise and shock decreased rapidly toward the downstream end of the tunnel.

Both noise and vibration increased as the tower water level dropped farther, until at elevation 1023 the test was stopped because of the severity of the conditions. Movement of the ½-in.-thick

(*Continued on page* 202)


I WANT HIGHER REACTANCE!
LESS NOISE
YOUR PRICE IS TOO HIGH!
I WANT LOWER REACTANCE AND LOWER COPPER LOSS!
I WANT LOWER IRON LOSS!
TOO BIG!
TRANSFORMER DESIGNER

When you specify designs for other than standard performance . . .

Wanted characteristics may play major $ role in transformer design

By **E C WENTZ,** *Transformer Engineering*
Westinghouse Electric Corporation

► FIRST TRANSFORMER DESIGNERS were quite satisfied if they could design a transformer to carry load without burning up. Next, they learned how to make this transformer at reasonable cost. Then competition between makers became keen in the constant battle of designing for lower losses and voltage drop . . . and at a cost low enough to be attractive.

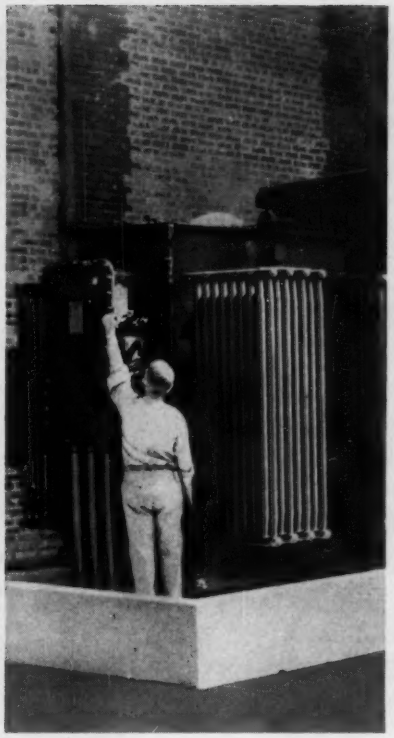
With experience, certain characteristics shaped up as about optimum from an economic angle. For losses in particular there appeared a certain level above which the saving of one kw loss would cost more in the transformer itself than a kw is worth. Similar levels popped up for other characteristics —hence, establishment of our present standard performance ranges. Since several characteristics are dependent on each other, it is difficult to vary one without all others being affected to some degree.

Sure, designing "special" transformers is within the designer's province. But a look behind the scenes at what the designer goes through in meeting off-the-beat specs is helpful to all engineers who specify transformers.

True worth of a given characteristic varies with circumstances. If power is cheap, as at a generating station, a kw of loss is not worth nearly as much as it is 100 miles away. Worth of, say, low regulation is even harder to evaluate. Sometimes it's essential to build a transformer with high internal impedance to limit the possible short-circuit currents to a value the circuit breakers can safely handle. But higher impedance means higher voltage drop in a transformer under load. Also, it is not unusual to design a transformer having an unusually low impedance and low iron loss.

IMPEDANCE, LEAKAGE REACTANCE

Transformer's internal impedance is mostly reactance in large units. This impedance is a desirable feature when we want to limit short-circuit current.



Facts that influence transformer economics

1. Losses, reactance and noise level are related variables.

2. High reactance and relatively low core-loss (below the standard ranges) are economically had in a forced-oil forced-air (FOA) transformer.

3. Low reactance, relatively low load-loss units (below the standard ranges) are attained economically in a self-cooled (OA) design, which may be fitted for future FOA cooling to handle greater load.

4. High reactance and low load loss (outside the standard ranges) are characteristics that cannot be wedded with any degree of economy. Nor do very low reactance and very low load loss go together.

5. A low noise-level transformer is basically a higher-voltage design operated at lower voltage. Such a unit may have low efficiency, high regulation, and generally costs more.

for dry-type or . . . **oil-filled units, . . .** **check these factors . . .**

But it's troublesome if we seek maximum voltage and kva to get through to the load.

Similarly, designers find reactance both a help and a handicap during a specific design. To achieve a very low reactance is costly, while to design it exceptionally high adds so much to the transformer loss that it ultimately increases cost too. There could well be an optimum range of reactance values from an application angle and a second range from the designer's viewpoint. It would be most convenient if both these ranges were the same. But experience shows the best range of values for operators is greater than it is for designers. One reason is the wide variance in conditions met in the field. In one part of a distribution system, low reactance may be desirable, in another a high figure is necessary.

Reactance and cost. To understand the practical relationship between cost and reactance, consider a transformer having but two pancake coils: primary and secondary. First off, appreciate the fact that internal leakage reactance exists in any transformer because some of the magnetic flux linking the primary coil fails to link the secondary. Flux path is sketched on p 102. To reduce reactance we must reduce leakage flux.

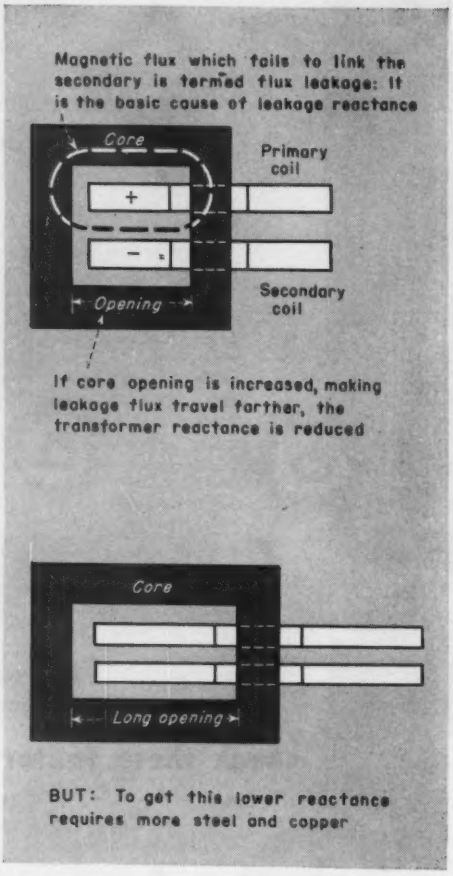
Chopping back on leakage flux means increasing core-window opening so the leakage flux has farther to travel. Trick works fine unless the window must be increased so far that core weight, loss and cost increase beyond reason. Increasing opening of core window ups the average length of a coil turn, raising copper loss and weight. So with both cost and losses increasing, only a limited change in reactance is practical by varying core-window proportions.

Another way to trim leakage reactance involves reducing the number of turns in both windings (reactance decreases nearly as the square of the turns). However, this leads to a larger core section since fewer turns mean core flux must be greater to induce the same voltage. A higher core loss (no-load loss) results immediately. Although fewer turns result in a lower winding loss, turn length must increase to fit around the larger core.

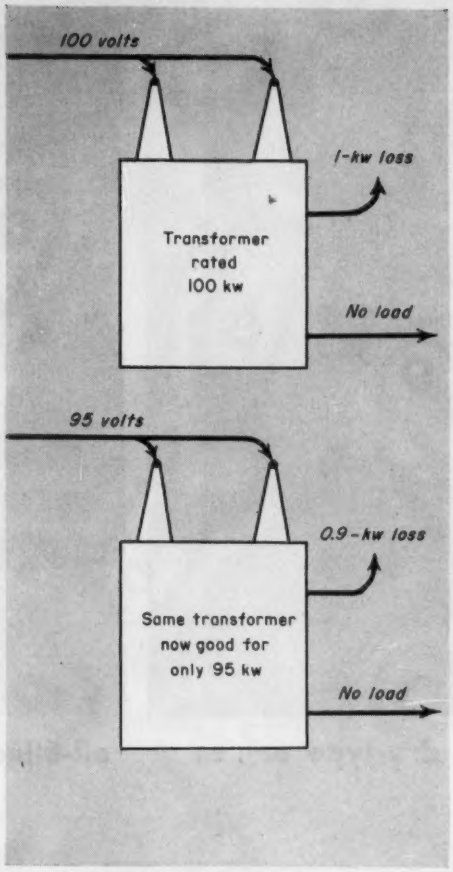
But what's really happening? As a result of fewer turns, iron loss goes up, load loss and reactance come down. At the same time, cost increases. Reason for latter is that iron cost goes up faster than copper cost comes down. Let's try another approach in understanding the problem . . . and solution.

Another tack. For the moment, go back mentally to the point where we decreased turns and increased iron section. This is exactly what we would do in designing a larger transformer. And what we came up with was simply a larger transformer, but with copper cross section cut down to carry the original current. We now have a transformer costing less than if we simply followed through and designed a larger transformer yet at a larger cost than the original design. Actually, we would have received a better value by building the larger transformer. Although larger unit has more capacity than needed, it may well come in handy to meet tomorrow's loads. And although the no-load loss is higher, total loss will be lower, perhaps enough to balance out the added cost.

When we want to increase reactance, the opposite is true. As iron loss goes down, load loss goes up and cost drops. Here it appears best to simply make a smaller transformer, except that the smaller transformer will not carry the required load. But fans and oil pumps can be added, making the unit suitable for the higher load values. Of course,


Magnetic flux which fails to link the secondary is termed flux leakage: it is the basic cause of leakage reactance
Core
Primary coil
+
−
Opening
Secondary coil
If core opening is increased, making leakage flux travel farther, the transformer reactance is reduced
Core
Long opening
BUT: To get this lower reactance requires more steel and copper

Leakage reactance value and . . .



no-load losses are not a problem . . .

we then find transformer efficiency has gone down and it's mighty costly to get it back up. *Sensible thing, usually, is to take the higher losses that go along with the higher reactance.*

TRANSFORMER LOSSES

Losses in any transformer have a *no-load* and *load* component. The no-load loss occurs in the iron core with minimum current flowing in the primary winding. Load loss results from load current flowing thorugh the primary and secondary windings.

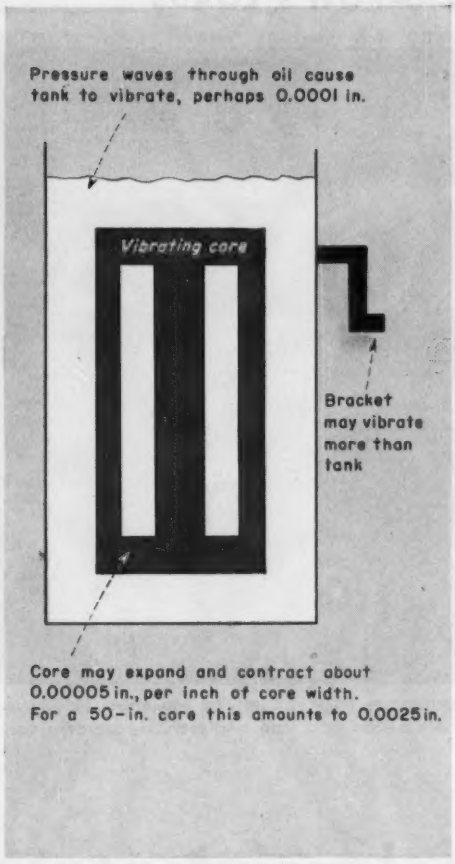
No-load loss can be reduced by reducing transformer voltage. This step alone decreases the no-load losses about as the square of the voltage. So let's follow through on what happens by simply lowering applied voltage, leaving transformer design constant.

If we want but 90% of the present loss, voltage is cut to $\sqrt{.9}$ or about 95%. This seems practical until we realize that in so doing we have lost 5% of the effective transformer capacity. Is there a better way to reduce no-load losses, say by 10%? To get the answer we call in the transformer designer, asking for a 10% drop in no-load with less than 5% loss in kva rating. Any suggestions he comes up with should not affect the cost nor the value of load loss. After calculating for a day or so he is able to get perhaps ½% of the lost kva back again —a mighty small improvement. Actually, he would be unable to get any of it back if the transformer were designed for minimum loss originally.

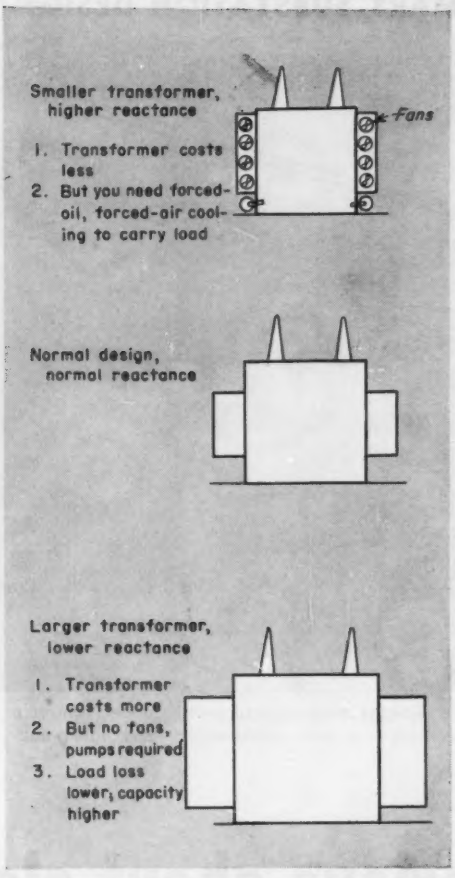
The designer will carefully point out that although load loss remains the same, load loss in percent of the new kva rating is 5% higher. And to get it back down we must reduce current output nearly 2.5%, ending up with a transformer having the 10% lower core loss we wanted, but only 92.5% of the capacity. And the cost has gone up slightly to boot! This looks like the hard way to get lower no-load loss.

Is there an easier way to drop no-load loss? Well, suppose we simply buy a smaller transformer. It has lower no-load loss but the full-load loss is higher. And a smaller transformer may overheat handling the present load. So we put on forced-air and forced-oil cooling. The load losses and reactance are still rather high, but we have saved real money by buying the smaller transformer. *If you want lower no-load loss, a forced-oil, forced-air FOA transformer should be your best answer.*

Keep in mind that temperature is the limiting factor in transformer loading. Heat affects life of winding insulation and oil when it's used. The hot-test spot temperature is result of four factors: (1) ambient temperature (2) average oil-temperature rise over ambient (3) average copper-temperature rise over oil temperature (4) hottest spot copper temperature over average copper temperature. If any one or more of these four can be lowered, insulation will be cooled and additional load may be carried.


Pressure waves through oil cause tank to vibrate, perhaps 0.0001 in.
Vibrating core
Bracket may vibrate more than tank
Core may expand and contract about 0.00005 in., per inch of core width. For a 50-in. core this amounts to 0.0025 in.

but noise elimination and . . .


Smaller transformer, higher reactance
1. Transformer costs less
2. But you need forced-oil, forced-air cooling to carry load
Fans
Normal design, normal reactance
Larger transformer, lower reactance
1. Transformer costs more
2. But no fans, pumps required
3. Load loss lower, capacity higher

optimum size are still toughies

Fans blowing on tanks and tubes drop oil temperature, allowing up to 30% load rise. Fans brush off air film clinging to surface of radiator, improve heat transfer.

Trimming load loss. By reducing load current 5% we can drop load loss 10%. But once again we have lost 5% of the transformer rating with little chance of getting much of it back. There is little that can be done with the external parameters that will effectively influence transformer load loss.

NOISE LIMITS

Transformer noise is caused by core expansion and contraction when magnetized and demagnetized 120 times each second. This is called *magnetostriction*. Noise you hear is usually developed by the tank vibrating as it's driven by the core. No practical way has been worked out to hold the tank from moving.

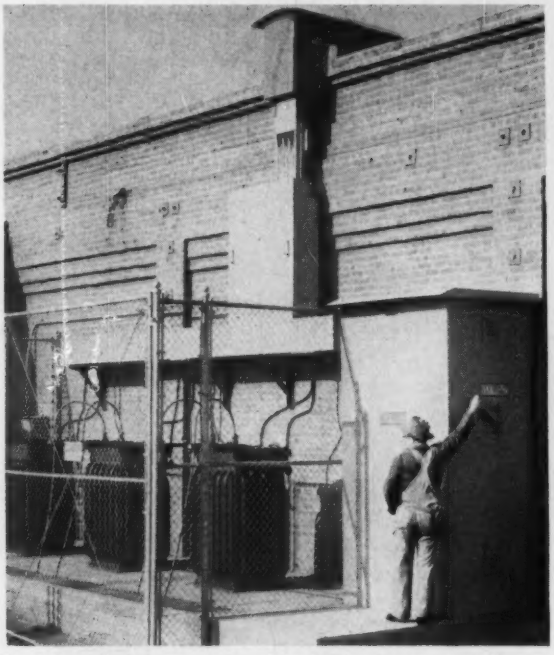
Any transformer element, such as an operating handle, cabinet bracket or door, arrester support, relay arm, radiator tank panel, may have a natural frequency of vibration equal to one of the transformer noise frequencies. And if it does, vibration of this element becomes amplified many times. Actually, it is hard to reduce the basic noise level, but any number of things can contribute to making this basic level worse.

Two-step approach. A double-barreled approach to noise reduction involves first tending to resonant parts and then reducing the driving force. The latter calls for reduction of magnetic induction. In the basic transformer this can be done by lowering voltage. Some typical noise-level figures for one particular transformer, which might well be kept in mind, are:

100% voltage	75 decibels
90% voltage	72 decibels
110% voltage	79 decibels

The above clearly shows what penalty must be paid to get even a small change in noise level. Keep in mind that when voltage is reduced 10%, effective transformer kva drops 10%. So we have to sacrifice 10% transformer capacity just to get 3 decibels of noise reduction. Efficiency is also affected in this proposed move. Although the iron loss may be 15 to 20% lower at the reduced voltage, copper loss remains the same. So to bring transformer efficiency back to the original value, more copper must be added—nearly 10%. Thus in reducing noise we have not only derated the transformer 10% but increased its core loss, size, weight. Reactance has not changed, but % reactance drop at reduced voltage and kva has increased.

So if reactance must also be brought down to the original value, the transformer becomes even larger, more expensive. At some value of noise level, about 10 to 15 db below the standard level, size increase is such that physical volume alone makes it produce more noise. At this point it's simply impossible to reduce noise level, at any cost, unless all efficiency factors are ignored.



1 High-voltage steel-encased switch, under control of plant electrician, is safe dollar-saving idea for primary subs

2 Instruments built into service equipment simplify running check on the plant load, and everyday operating conditions

Serious about electrical maintenance? Try these distribution-design hints

Laying out an electrical-distribution system, with an eye toward maintenance, starts on the design board . . . with materials

By R S WILSON, *Senior Electrical Engineer, California Packing Corporation*

► SMART, MODERN DESIGN in the industrial power-distribution picture calls for a close look at initial investment, safety, operating reliability, flexibility. Convenience and space requirements are prime factors, too. But atop this list of basic considerations is the never-ending need to adopt new materials and techniques. Looking at the distribution scheme from stem to stern, here are some of the elements you might well consider.

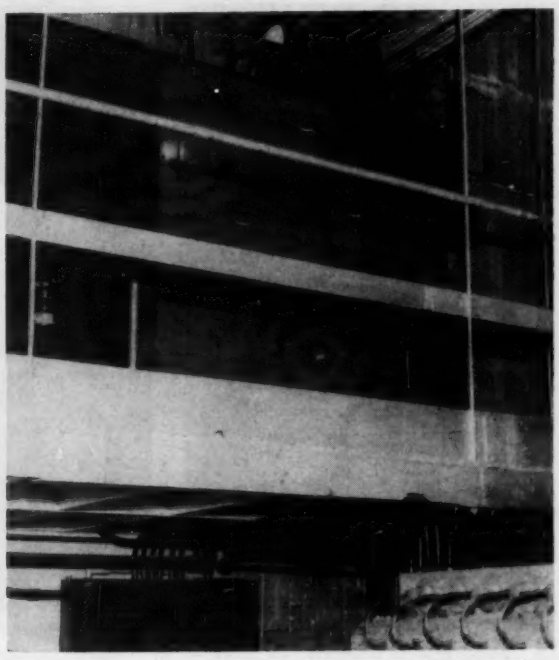
Service equipment in the primary substation should get a close scrutiny. We find outdoor-type steel-enclosed high-voltage switches a good bet as main disconnects for utility feeders. A well-placed manual switch, Fig. 1, right in the primary leads to the transformer is really a cost saver. Reason: Cost of high-voltage switch is below that of a low-voltage switch of same capacity. And there are times when it's impossible to get a low-voltage switch big enough to handle the maximum kva a high-voltage switch takes with ease.

Adequate space is another important design consideration. When you're laying out a primary sub, leave room for expansion. How much room? We provide for possible doubling, even tripling, of original transformer capacity in a sub designed generously to start. We recommend the load-center plan of carrying high-voltage close to actual load areas (POWER, Oct 1953, p 86).

Instrumentation on the main panel, Fig. 2, pays off when making load studies and simple everyday checks. It's

THESE MOTOR-CONTROL CENTERS OFFER TOP SAFETY

3 Custom-designed motor-control centers have proven safe, convenient, low cost, in this food-processing installation



4 Elevated platforms take control centers off floor, where space is at a premium, place them up in drier environment

important to figure in instruments on the original design since space limits in modern gear all but prohibit future installation of current transformers. As a plant grows, measurement of actual load becomes increasingly important. Photo, Fig. 2, shows section of a main entrance-breaker panel with ground-detector lamps, ammeter selector switch to transfer ammeter to each of the three lines, and a meter test block. Other instruments could be installed, such as watt-meters, pf meters, meters to govern automatic switching of capacitor banks. Test block simplifies attaching portable indicating or recording instruments. Remember to specify pt's and ct's big enough to handle all test instruments that may be installed.

Motor-control centers we adopted, Fig. 3, are custom built. We figure they save about 60% of the cost of their more intricately built counterparts. Ample wiring gutters and isolating barriers between starters are major design features. By standardizing dimensions, these custom-built motor-control centers can be manufactured by different suppliers and placed side by side. Plant specs assure uniform appearance.

Our control centers come from manufacturer, wired between switches and starters, ready to set in position. Note that on-the-job changes in control centers present little problem. Door-in-door construction provides easy access to gutter spaces. Hinged trims end need for lifting heavy front panels to expose wiring gutters; one man does it.

Locks on switches and doors keep idle fingers out of live parts. But it's still possible to test or adjust without shutting down machines. Note small switch to left of each motor starter. These are placed in the circuit where one starter is controlled from contacts on another. By opening these interlock switches and disconnect switch for proper starter, the hazard of shock is eliminated. Barriers between starters prevent tools or hands from slipping onto a live line.

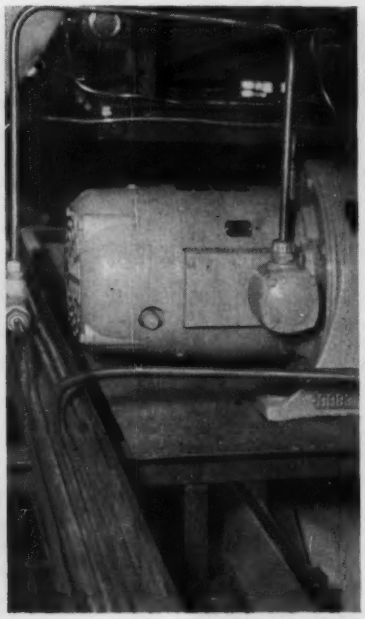
Elevated platforms for control equipment, Fig. 4, serve two purposes (POWER, Oct 1953, p 95). First, they keep the gear away from valuable work space. Second, they present a reasonably dry area for electrical equipment. This latter factor is most important in a food-processing plant. If you plan to use platforms, design them wide enough for free opening of doors:. Provide a railing and toe-board.

Interlocked switches and receptacles, Fig. 5, supply built-in safety for workmen plugging in portable power tools. Typical setup involves a type-A switch to which is fastened a steel box with a hinged cover. Box is below switch. Covers of both switch and box are permanently fastened together. Lower box, Fig. 5, houses a plug receptacle. To remove or insert plug, it is first necessary to open switch. With switch and door open the receptacle can be reached. Keep operating handle within 6½ ft of floor.

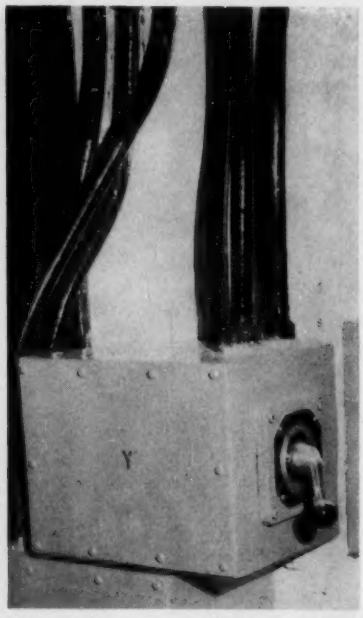
New wiring materials, which are being developed at a lively clip, should be considered in every new design. These newcomers are licking problems that have been irking engineers and plant electricians for years. Typical is mineral-insulated cable (MI by General Cable Corp), Fig. 6. Made up of bare copper wires insulated with magnesium oxide and encased in copper tubing, cable may be installed without conduit (POWER, Jan 1954, p 102) or supported in cable troughs. When used with the terminals provided, it's fully watertight. Since cable can withstand high temperatures, the principal limiting factor in choosing wire size is voltage drop.

Similar cable has an aluminum sheath (*Okotherm* by Okonite Corp). It's a cinch to strip the aluminum sheath from the *Silastic* and glass-insulated wires, Fig. 8. Where salt or acid might

5 Switch, receptacle interlock prevents plugging in or disconnecting portable tools before first opening the switch



6 Metal-sheathed wiring does not require conduit, handles temperature extremes: It's watertight, salvable



7 Neoprene cover over aluminum sheath protects cable against salt, acid. Cable ends are taped, varnished

attack the aluminum, cable is covered with neoprene and tape. Any combination of wire sizes can be made up and different-colored tracers incorporated in the glass braid. Conductors are copper. The combination of *Silastic* and glass covering gives this cable Class-H properties. Typical installation in one of our plants, Fig. 7, has box fittings taped to keep moisture out.

Flexible conduit with a neoprene jacket (*Sealtite* by American Brass Co) is another wiring material well suited for many plant applications. It is available with a copper grounding conductor rolled into the spiral armor. Special fittings provide both a bushing, completely covering edge of conduit, and a bond to ground.

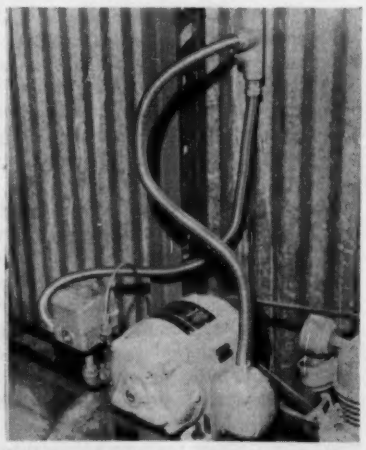
More recent addition to the pliable-tubing family is shown in Fig. 9 (*Plica* by Callahan Zinc-Lead Co). It can take a small-radius bend and retains a given shape after being hand bent. Makers claim it withstands liquid and gas pressures to 40 psi.

We found *Silastic* and glass-tape wire insulation well suited for high-temperature applications. Typical: Leads for ovens, motors, transformers. It has neatly solved the problem of dried and cracked insulation faced up to in regular insulations. The silicone family has solved another problem for us too: silicone grease to keep infrared lamps from sticking in sockets. By applying a light coating of silicone grease to lamp's screw base before inserting in socket, the lamp can be removed easily without the glass envelope breaking away from base.

Conduit seals, although far from new, have proved mighty important to prevent migration of moisture in conduit. Seals are especially useful where conduits run between plant sections operating under a marked difference in humidity. As a case in point, our food-processing operation gives off liberal quantities of steam in some plant areas. Steam rises to upper parts of the plant without special venting. This vapor could enter a NEMA I enclosure, then be carried through conduits to lowest point in the system, condensing on the way.

Avoid connecting NEMA IV equipment to NEMA I wiring without providing for sealing and draining. Why? To keep steam out of pushbutton stations and motors. In NEMA IV enclosures, moisture collects until equipment fails. Final thought: If moisture is a problem in your plant, consider weep holes along lowest point in conduit runs and in totally enclosed motors.

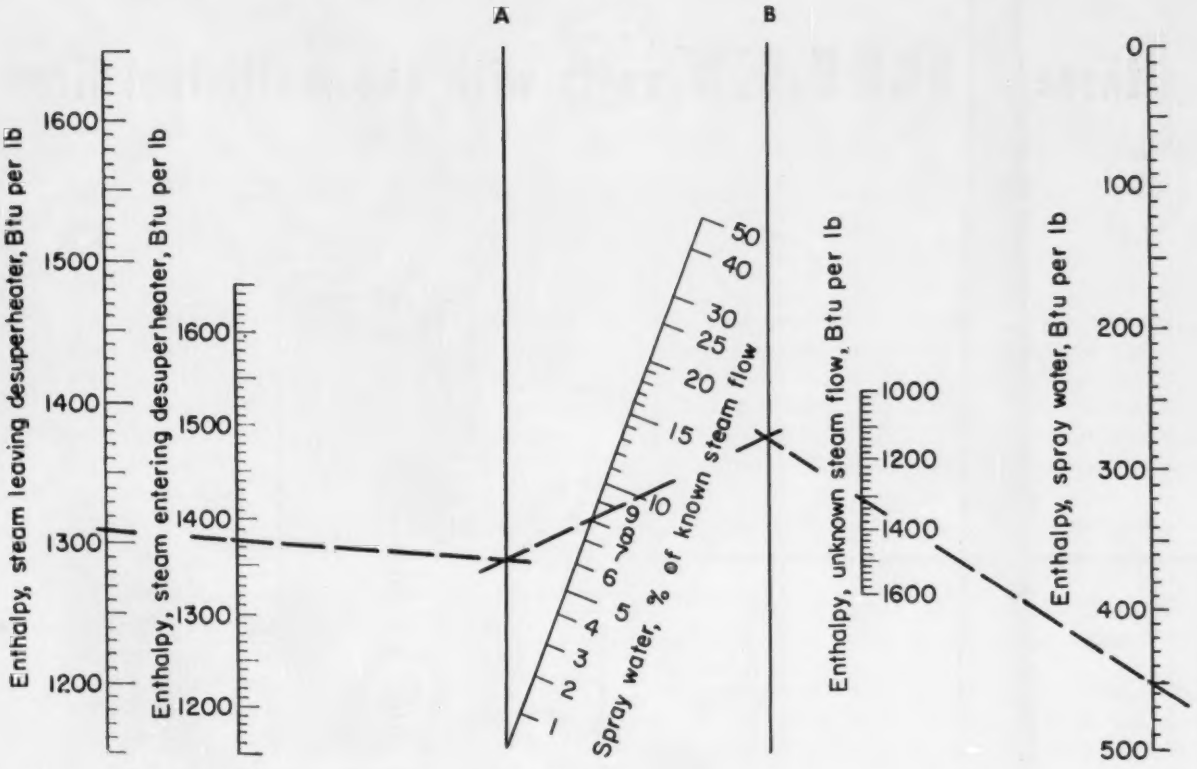
8 Aluminum-sheathed cable is easy to strip, install. No conduit is needed; cable terminals are simple to make



9 This pliable tubing makes sharp radius bends; maker claims it will withstand liquid, gas pressure to 40 psi

Power's DATA SHEET

No. 286



Spray-water flow to steam desuperheaters

► BOTH INDUSTRIAL PLANTS and central stations make use of desuperheaters and attemperators. Normally only one of the steam flows will be metered. But since pressures and temperatures of both steam flows and spray water will be metered, the spray-water flow and unknown-steam flow can be figured.

Knowing pressure and temperature of each flow, we can go to the steam tables and find their enthalpies. With these data we then use either of the following formulas to find ratio of spray-water flow to known steam flow:

$$W/S_1 = (h_1-h_2)/(h_2-h_w)$$
$$W/S_2 = (h_1-h_2)/(h_1-h_w)$$

where

W = Spray-water flow, lb per hr
S_1 = Steam flow into desuperheater, lb per hr
S_2 = Steam flow out of desuperheater, lb per hr
h_1 = Enthalpy, steam flow to desuperheater, Btu per lb
h_2 = Enthalpy, steam flow from desuperheater, Btu per lb
h_w = Enthalpy, spray water to desuperheater, Btu per lb

The nomogram above can be used for either formula.

Example: A flow of 950,000 lb per hr of 1380-Btu-per-lb steam is desuperheated to 1310 Btu per lb with 450-Btu-per-lb spray water before entering a boiler reheater. How much desuperheated steam leaves the reheater?

Find the 1310 Btu mark on the left-hand scale above and 1380 Btu on the second scale. Lay a straightedge across these to intersect with the index line *A*. Next lay a straight edge from 450 Btu on the right-hand scale to 1310 Btu on the second-from-right scale to intersect with the index line *B*. From the intersections on *A* and *B* lay a straightedge to intersect with the center scale and find the answer: 8.1% of incoming steam flow equals spray-water flow, or 76,950 lb per hr. Then flow out of reheater is 950,000 + 76,950 = 1,026,950 lb per hr.

CHARLES B SCHUDER *Metropolis, Ill.*

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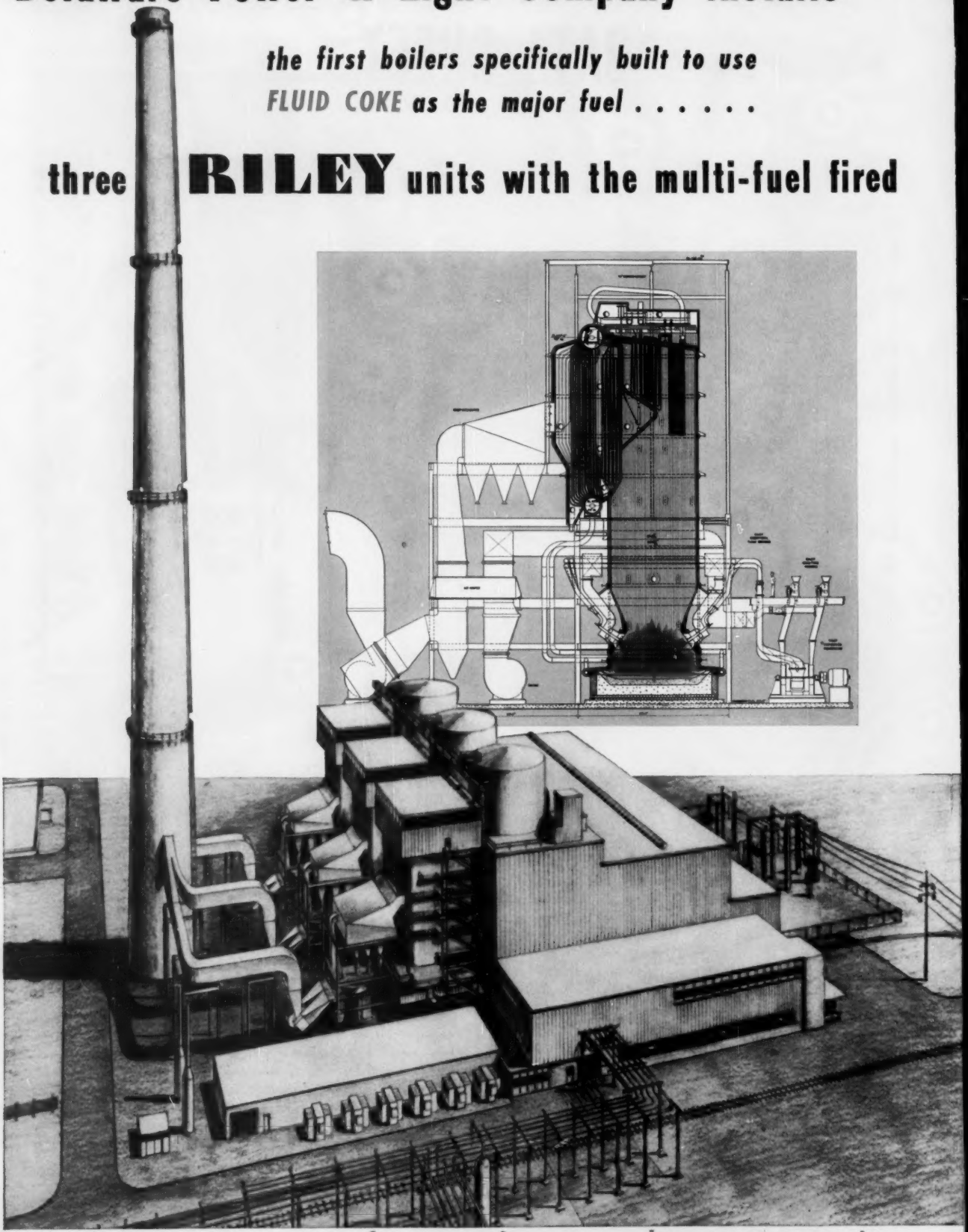
Delaware Power & Light Company installs

the first boilers specifically built to use FLUID COKE as the major fuel . . . . . .

three RILEY units with the multi-fuel fired



RILEY designs, engineers, manufactures and erects complete steam generating

TURBO FURNACE

Delaware Power & Light Company selected three Riley TURBO FURNACE units for its Delaware City Power Station which will supply steam and electric power requirements of Tide Water Associated Oil Company's new 130,000 barrel-per-day Flying "A" Refinery in Delaware. These units were designed particularly for efficiently firing fluid coke with a minimum of auxiliary fuel.

To burn low volatile fluid coke a furnace providing high heat concentration, high turbulence and sufficient residence time for burnout is necessary . . . and Riley's TURBO FURNACE meets these requirements. The coke, pulverized by Riley Mills, is introduced into the furnace combustion chamber by Riley Directional Flame Intertube Burners arranged for opposed firing. Fluid Coke is largely carbon; therefore, a reinjection system is used to burn the catch in the dust collection system. The design of the burners and the TURBO FURNACE will also permit the burning of refinery gas, oil and coal.

C. F. Braun & Co — Engineers and Constructors

ADVANTAGES of RILEY TURBO FURNACES

- Efficiently uses a wide range of coals, oil, natural and refinery gases, fluid coke, delayed coke, lignite.
- Lower carbon loss, higher efficiency
- No slag blowers required
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- No fly ash disposal problem
- All burners on one level
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Three Riley TURBO FURNACE Units
Steam Capacity — Each 500,000 lbs/hr.
Design Pressure — 1425 psig
Steam Temperature — 950 F.
Fired by Riley Mills

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

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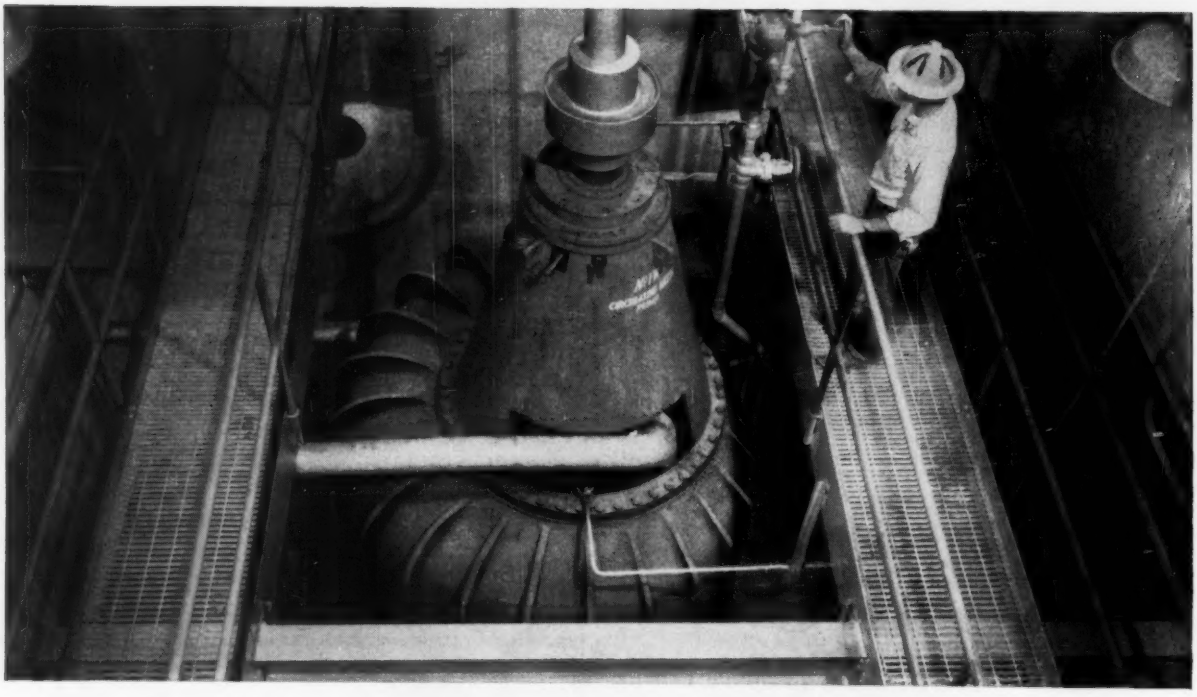
Allis-Chalmers

PUMPS Meet Power Plant Requirements



Heavy-Duty Construction Helps Assure Service Continuity

At Clifty Creek Plant of the Indiana-Kentucky Electric Corporation, the use of 12 Allis-Chalmers vertical condenser circulating pumps for dry pit installation helps to assure service continuity and reduced maintenance.

Rigid whip-free shaft, protected oil-lubricated bearings, and special new-type rib construction that makes casing stronger and saves space — these are some of the features that make A-C circulating pumps popular throughout the power industry.

For the complete story on how Allis-Chalmers pumps can help you cut costs, contact your local Allis-Chalmers district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

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STEVE ELONKA
Associate Editor in Charge

At Philadelphia Electric Company . . .

Consolidated shops mean better maintenance

By WILLIAM D SHAY, *Partner*
Howell Lewis Shay and Associates

► COMBINING three separate maintenance and construction headquarters into one modern building gives Philadelphia Electric Company several major benefits: better work schedules, more facilities for each department, saving in trucking work back and forth, less need for contracting jobs to outside companies.

Here's the story of what was done, and how it is benefiting company operation.

Before consolidation. Maintenance was carried on in three separate shops: Schuylkill Generating Station, former headquarters of Operating Maintenance Division of the Station Operating Department; Engineering Department Construction Division Headquarters; and a pole lot occupied by both departments.

Since consolidation. Shop requirements of the two divisions are combined. Management felt this would be an advantage since maintenance work is unpredictable, but construction can be planned and scheduled. By consolidating, they could take advantage of lows and peaks in maintenance. In addition, the large, new central stores area helps correlate work in a functional arrangement.

Supervision is improved by the integration. Formerly, each group had its own foremen. Now, one man can direct activities that had to be supervised independently.

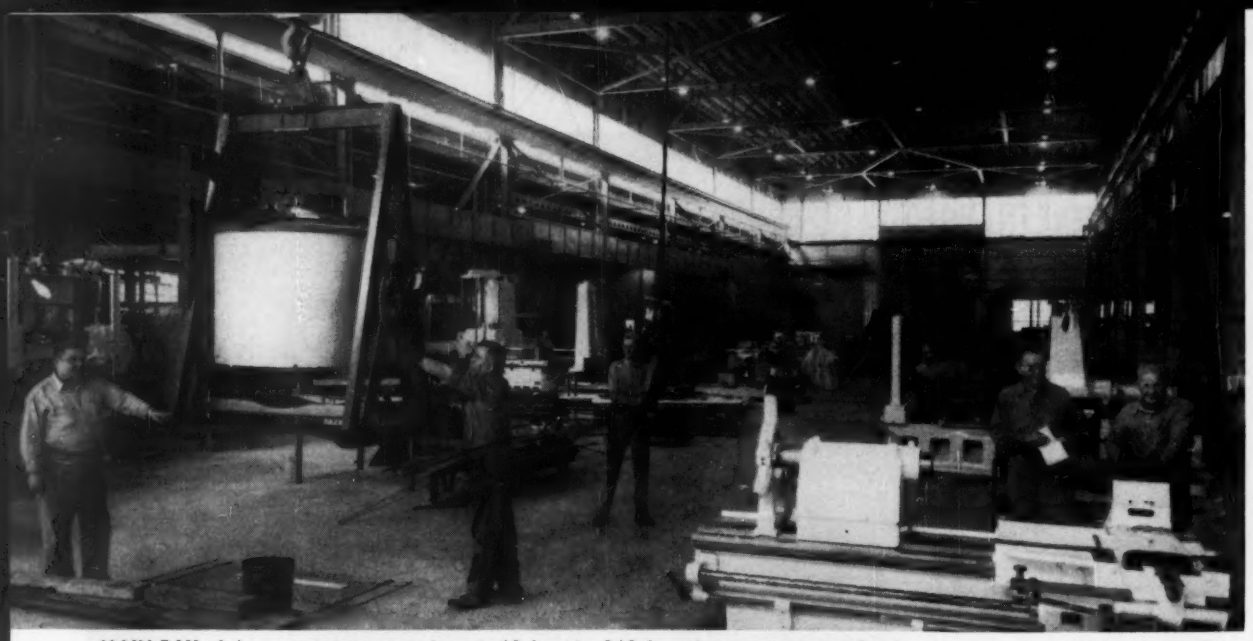
Personnel accommodations are better. There are more parking spaces, more lockers, model rest rooms with showers, and for each shop group, a separate lunch room with stoves, refrigerators and sinks.

Although the shops are equipped to handle a large volume of work, some big jobs are still contracted to companies better equipped to handle them.

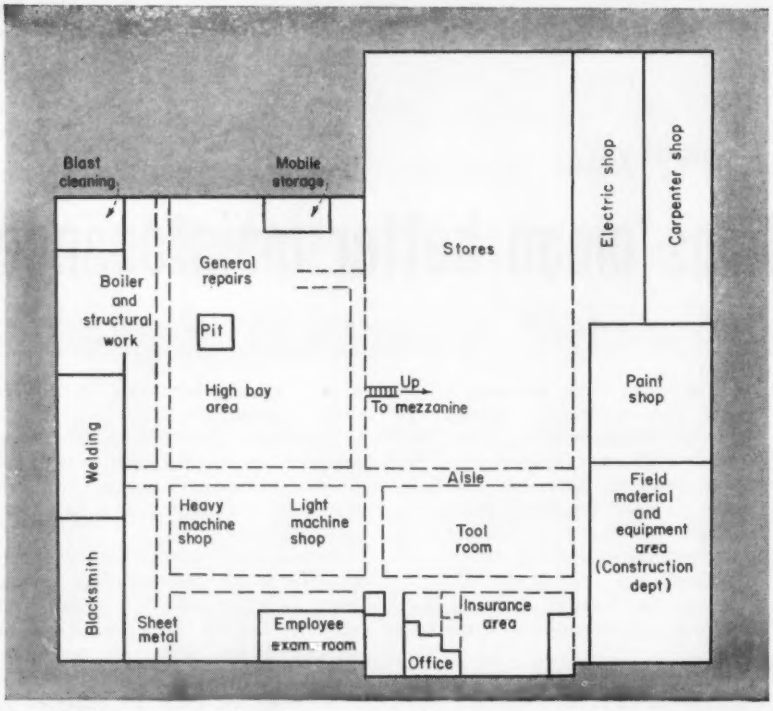
Branch shops continue servicing some equipment, but the new 145,000-sq-ft one-story and mezzanine structure (photo) is the heart of maintenance for all electric, gas and steam plant equipment. About 175 men work in the new $3-million building, known as Oregon Maintenance Shops.

Labor was not cut. But work is done faster in the new plant with lower outage time, say company spokesmen.

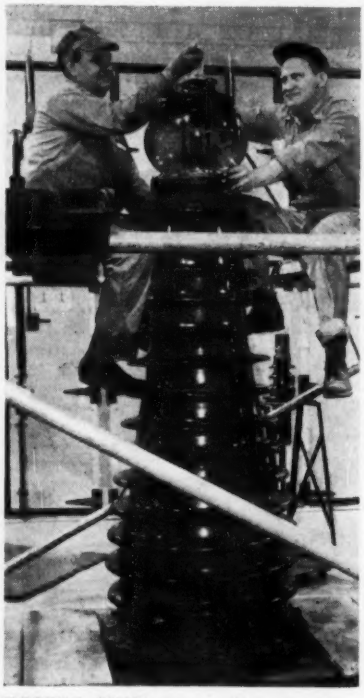
For instance, a recent repair job on 220-kv bushings for Conowingo Hydro-



MAIN BAY of the new maintenance shops is 60 ft wide, 260 ft long. It houses the general repair area and heavy machine-shop equipment. Overhead crane runs length of the floor. Modern lighting, heating, ventilation make area comfortable



FLOOR PLAN of new building shows functional arrangement of all the shops around the stores area. Tool room is also centrally located. Most offices are upstairs



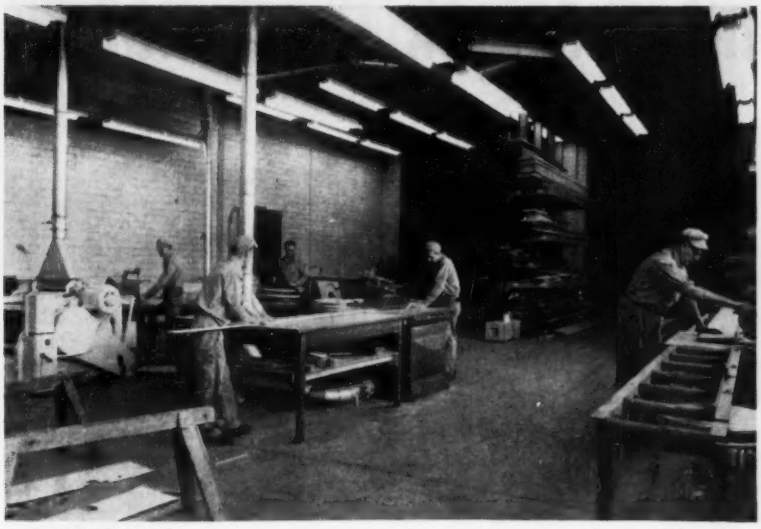
ELECTRIC SHOP area is big enough to handle large units like this bushing

electric plant was completed in minimum time. Previously, the bushings would have been shipped to Plymouth Meeting, Pa., where a substation has crane capacity and handling room. Men and equipment would have been sent to the suburb, work treated as a field instead of a shop assignment. The job would have taken all day.

Building layout. About 70% of the ground-floor area is occupied by electric, carpenter, paint, insurance, machine, boiler, steel-fabrication, sheet-metal, blacksmith, welding and specialty shops, together with associated offices, tool room, first-aid room and employe lunch rooms. The Field Material and Equipment section, supplying field forces' needs, takes up about 7% of the space. Remaining area is a consolidated storeroom (see sketch above).

Ground-floor work areas are divided into 40-ft-wide bays except for one high-bay area. The four low bays have 5-ton 15-ft-headroom overhead cranes. The high bay is 60 ft wide and 240 ft long, equipped with a 25-ton 25-ft-headroom overhead crane. All cranes are pendant-controlled from the floor.

A 15-ft-deep pit in the high-bay area



CARPENTER SHOP is well lit and in an easily accessible spot in the building. Note modern lighting, adequate work space and room for more equipment when needed

INSURANCE SECTION. Employes inspect firefighting equipment for serviceability

is used for dismantling and repairing transformers, turbine rotors, etc.

The mezzanine floor provides enlarged offices for planning, clerical and supervisory personnel, as well as central wash and locker rooms, rest rooms and a mechanical room for boilers and air-conditioning equipment.

Toilet and lunch rooms are near the shops to keep men from traveling too far. And tile markers in the floor define the aisle pattern through shops and offices without erecting barriers.

Material handling is mechanized where feasible. Shipping and receiving facilities are streamlined, expediting work flow. Some units are trucked into a receiving vestibule that operates much like a lock system, keeping cold air out of the shop in winter. In old quarters, air sucked in through the doors sometimes affected tolerances on high-precision lathe work.

One central tool room serves both departments, for greater flexibility. Most equipment from the old shops was moved into the new one. But belt-driven machine tools at the old construction headquarters were replaced.

The Stores division occupies a large area. The mechanical, electrical, paint and carpenter shops all surround Stores, providing easy access for each group. There is more space in the new storage room, and about a 40% increase in stacking height over the previous arrangements. Items are stored so the heaviest and bulkiest are nearest the door.

New shops. Shops and equipment new to one or both departments include sheet-metal, blast-cleaning, paint, mobile-storage.

Sheet-metal shop's major function is repair and maintenance, but some production work is done here, too.

Blast-cleaning area is indoors. To prevent nuisance, dust is collected in bins. Men working here wear personal protective equipment.

Paint shop was formerly at construction headquarters only. New features include paint scrapers, "pickling" room for removing paint and grease, a waterfall arrangement to take paint spray from the air. Air is drawn through the room, pulling paint spray into the water where it collects and is removed.

Mobile-storage area provides space for special tools. Formerly there was no particular spot for such equipment.

Bus-duct arrangement for power distribution provides 440-v 3-phase power throughout the shops. This is more economical than the 220-v 2-phase power available at previous stations.

Relocated shops include blacksmith, welding, electric, carpenter, insurance. Here are some of the new features:

Blacksmith shop boasts a large drop hammer mounted on springs below the floor, so no vibration is transmitted to the floor.

Welding shop has five individual booths, each with its own fume exhaust. There is much more room here than in the previous location. Number of welding jobs has grown rapidly since the war.

Electric shop has improved facilities for assembling and dismantling work, primarily on electric bushings. There is a small 10-foot dismantling pit, and improved oven facilities for drying cores. Other features of electric shop —special silver-plating room, and future high-voltage test set. This last will eliminate extra trips to Westmoreland test station where such work is now done.

Carpenter shop is more accessible than before.

Insurance-inspection area provides for repairing and testing fire apparatus. This is under jurisdiction of the company's Insurance Department.

Field Material and Equipment area was formerly part of the Construction division, is now serviced by the Maintenance division.

Architect's touch. The building was designed by outside architects.

Company engineers and department heads first developed a program of requirements and prepared preliminary plans showing basic size and layout. They also prepared base specifications for materials.

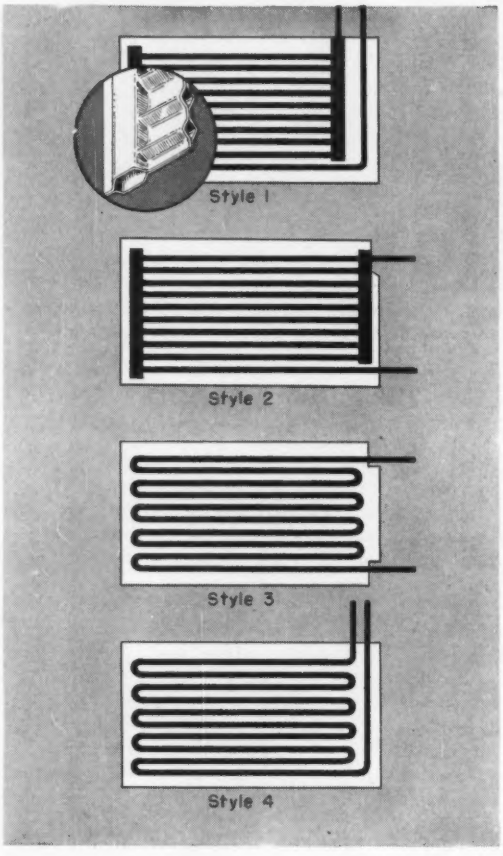
Philadelphia Electric engineers made a ¼-in.-scale model of the ground floor showing equipment, and the architects made a 1/16-in.-scale model of the building and site. The models helped tremendously in spacing and orientating equipment, and study of exterior treatment.

Builder proceeded with construction as drawings were prepared. First portion of the building was occupied 12 months from start of preliminary planning, and the remainder of the new area was in use four months later.

OPERATORS' NOTEBOOK 95

Don't overlook these handy

FOUR BASIC STYLES



How to apply

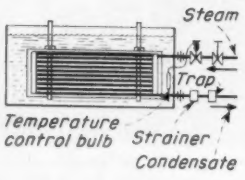
► PLATE-TYPE COILS give high rate of heat transfer for size. A 22x47-in. unit, only 1 in. at widest cross section, gives as much heat-transfer capacity as 32 ft of 1½-in. pipe coil of 30x60-in., claims the manufacturer.

Four basic styles above—1, 2, 3 and 4—have many modifications and sizes. Low-pressure steam is often used for processing with these units. Some advantages of steam with plate-type coils are: (1) usually available (2) low operating cost (3) accurate control (4) low maintenance costs.

These coils for steam use are available in materials and finishes for most corrosive applications. Often they eliminate need for special, costly jackets or external heat exchangers. Besides examples here, these units can be adapted to special machines for heating or cooling lube or hydraulic oil, for condensers, heat exchangers, refrigeration evaporators. Also for enclosing conveyor lines to heat or cool materials while in transit and for many other uses. Both water and refrigerants are commonly used as cooling mediums in some styles now on the market.

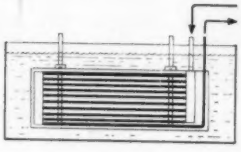
—Courtesy, Tranter Mfg, Inc, Lansing, Mich.

OPEN PROCESS-TANKS



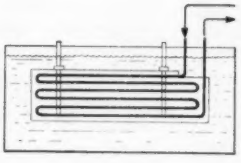
For heating

Installed through tank end, with fittings, for heating with steam, for Dowtherm or other heat-transfer medium. Standard hangers hold unit 1½ in. from tank wall for best results. Units are often used for metal cleaning, rinse, phosphatizing and pickling tanks. Several units can be in banks, or used on end in deep tanks with pipes above the liquid.



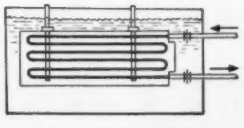
For heating

This style is of headered construction but has riser pipes to simplify steam and condensate piping. Design can be installed or removed without draining the tank. There are no threaded joints below the liquid level. Use where frequent removal for cleaning is needed, or if tank is below ground or has a lining that cannot be cut for the piping.



For cooling

Serpentine construction is most efficient for use with a liquid for either heating or cooling because of improved heat transfer, resulting from increased velocity. This may be water, brine or heat-transfer oil. Design shown is also preferable with refrigerants, as commonly used for cooling, plating and anodizing solutions or for your quench oil.



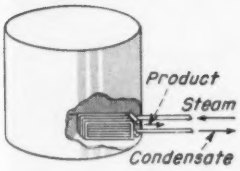
For cooling

Another serpentine design has end connections for hooking through tank's end or headered inside. Often installed on end for deep tanks. Flow of heat-transfer medium can be controlled with temperature regulating valve. This style may be better than headered for steam-heating jobs like asphalt, tar, wax, resin.

plate-type coils for heat transfer

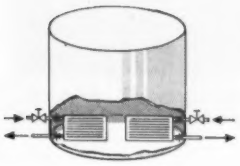
By STEVE ELONKA, *Associate Editor*

STORAGE TANKS



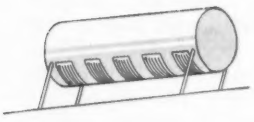
Internal mounting

Suction heating as materials flow to drawoff point. Install number of plate-type coils side by side as shown. Experience shows you can often start pumping as soon as steam is turned on even with viscous asphalt in cold climate. One reason is that resistance through these units is very low; they are more streamlined than is piping.



Internal mounting

Uniform heating throughout materials in tank comes from placing heaters at intervals around tank bottom. This gives large surface area with minimum piping connections. Cleaning sludge from tank bottom is easier than with pipe coils that usually congest the bottom. Men can do job in less time and more safely as they do not walk on piping.



External mounting

Single embossed units are well suited for replacing conventional steam jackets on horizontal tanks, sketch. Coils are rolled to conform to the tank curvature and thus provide a high percentage of contact area. Efficiency can be increased by using a thermal mastic between coils and tank. Fittings can be placed to drain all the condensate if needed.

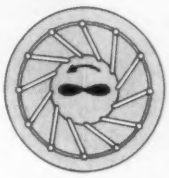
External mounting

Where product discoloration or some other adverse effect may result from high steam temperatures, you can use hot water in design shown. In one large installation for heating lube oil, steam is used, but the heating units are installed about 2 in. away from tanks. Coils and tank are then blanketed with suitable insulation.

OTHER APPLICATIONS

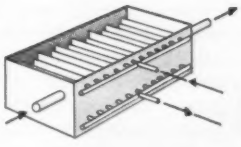
Agitated tanks

Plate-type coils can be used as baffles in agitated process tanks. Coils may do heating or cooling. For shallow tanks, a large amount of surface area can be provided by curving long units as shown. Install them with ends overlapping. Especially effective for low tanks having low liquid levels. Here, again, cleaning is easier as there is more room in tank.



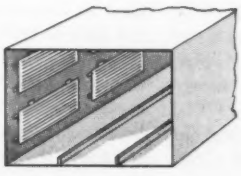
Agitated tanks

For deep tanks, you can install plate-type coils on end with pipes turned upward and connected into circular headers. This arrangement may be used for heating or cooling. Here maximum efficiency is obtained when solution is agitated. If desirable, system may be fabricated as a unit for easy removal and for cleaning. Handy for deep liquid levels.



Waste-heat recovery

Quench oil cooling, etc, calls for various heat-exchanger arrangements, depending on conditions. Here coils are convenient because cleanability is important. Series parallel connections shown can be made for greater efficiency where temperature differences are small. Various alloys and finishes permit the handling of most corrosives in common use.

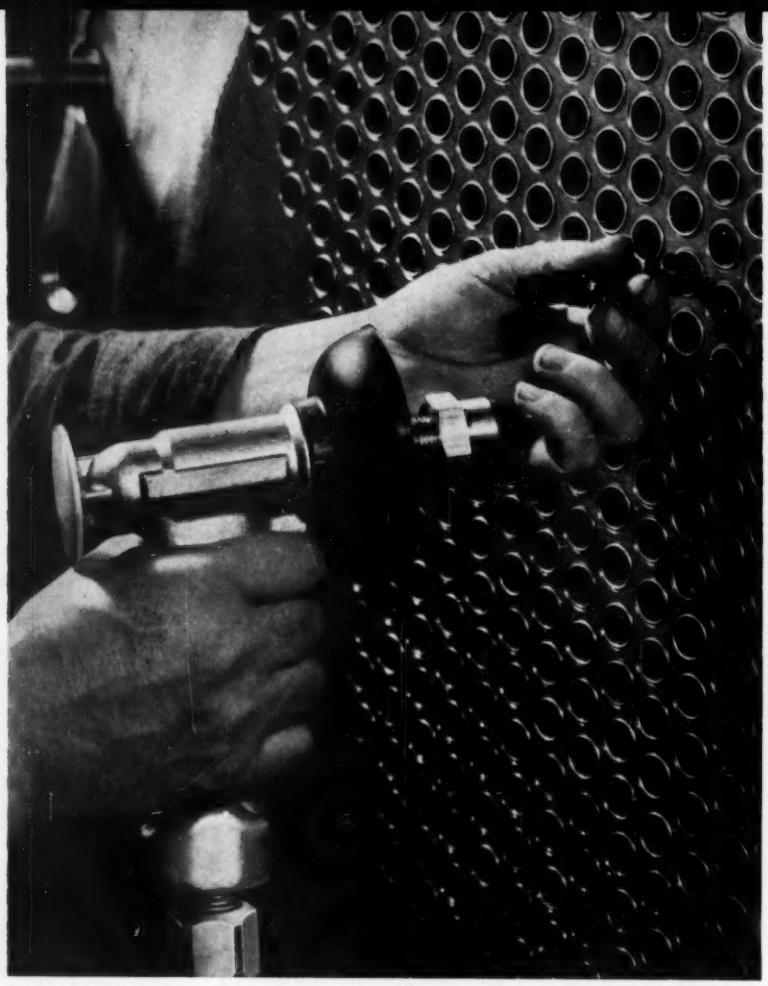


Oven and furnace

Heating or cooling air in oven or furnace can be done with these coils, as shown. Typical applications include ovens for drying paint and cooling sections of annealing furnaces for strip steel. Plate-type coils also make effective heat screens to protect workmen around the tapping spouts of open-hearth forging furnace and others.

STEAM

By H A BACH
Lagonda Division, Elliott Company



FAST CLEANING, no tube damage with jiffy gun and water-propelled free brush. Spiral-wound brush spins and scours. Water flushes soft deposit, slime from tubes

Formula for smart plant engineers:

Right tools + time-saving methods =

► How OFTEN should heat exchangers be cleaned? Several factors govern a schedule. From a maintenance standpoint, frequent cleaning means easier cleaning. But since demand determines length of production runs, cleaning becomes a matter of economics. Savings in maintenance cost, plus higher efficiency resulting from cleanout, must at least equal down-time production loss. So frequency must be tailored not only for the plant but also for individual processes.

But methods can be pretty well cut and dried. Size of tubes, amount and type of deposit are about the only variables in choosing method and tools.

Nylon brushes, or rubber plugs, propelled by water from a jiffy gun easily remove soft deposits like mud, silt, algae. Brushes have rubber bumpers slightly smaller than tube ID to allow water to pass, are spiral-wound to give spinning, scouring action. Big advantage of this method is in preventing damage to tube surfaces.

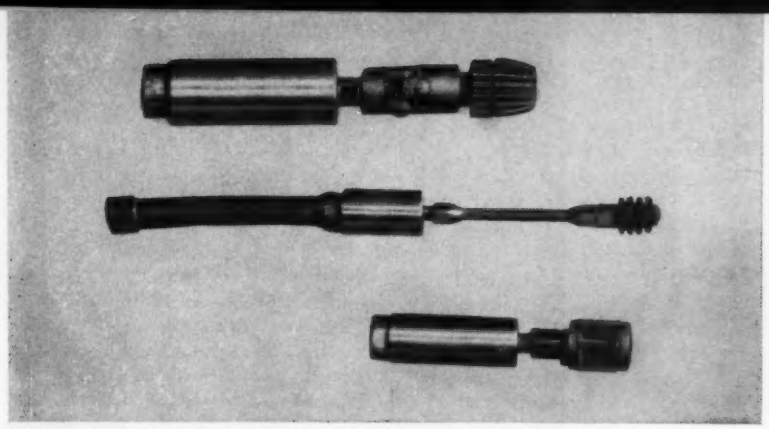
The gun operates at 70-psi water pressure but, if less is available, pressure can be boosted with air. Operation on air alone is possible, but water is preferred to obtain flushing action ahead of and behind the brush.

Method is fast, particularly with a 2-man team. One man positions brushes, the other shoots them through the tubes. Example: A 5000-tube condenser with ¾-in. 16-gage tubes, 16 ft long, can be cleaned by a 2-man team at the rate of ten tubes per minute. Two teams do about 1200 tubes per hr. Entire job, including preparation of the condenser, retrieving brushes, etc, can be done in less than one shift. Brush recovery is fast if rear head of exchanger is removed and a tarpaulin suspended to catch brushes coming from the tubes. Unless desired, heads don't have to be removed from divided waterbox units. Equipment is compact, can be used through handhole openings.

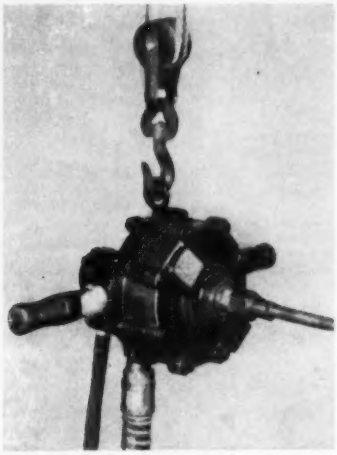
Internal-air-motor use comes into play when tubes have medium coat of scale. Traveling through the tube, driving revolving cleaning head, motor exhausts to the front, drives loose deposit out the far end of the tube. Motor lubrication is provided with the air stream. If oil is objectionable, any water-soluble lubricant can be substituted.

Cleaning head used depends on type of deposit. Wire brush takes care of light, dry stuff. Scraper head is best for sludge. Cutter is generally needed for scale.

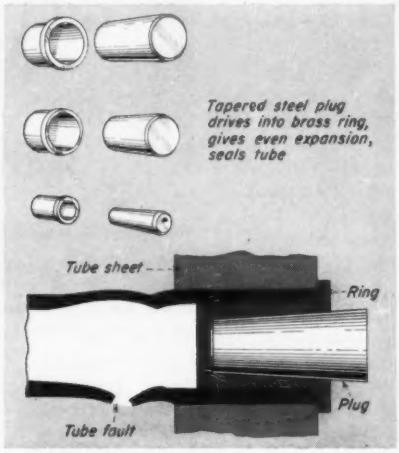
Motors are lightweight and easy to



INTERNAL-CLEANING MOTORS, powerful for size, bore through tubes coated with hard scale or gummy deposit. Motors need little clearance, use small volume of air



SUSPENSION CLEANER, trolley and scaffold, cut hard-to-clean job time



TAPERED STEEL PLUG expands ring. Seals bad tube with no tube-sheet damage

clean heat-exchanger tubes

handle, require little headroom and small air volume. Cleaning speed is fair. Considering the condenser previously mentioned, cleaning at the rate of about three minutes per tube, or about 250 man-hours for the unit is average. Because of small diameter, power is limited, and use of motors is not feasible in plugged or nearly plugged tubes.

Heavy, hard deposit takes externally driven cleaners. These drive a drill or brush at the end of hollow shafting through which flushing water is introduced to the tool. A pistol grip, air-driven type, has built-in water feeding device. With air and water valves at the motor, it is lightweight and needs no supporting scaffold. Where clearance is limited, coupled sections extend shaft as needed. Although husky for its size, motor has limited power and should not be expected to do extremely heavy work.

The real work horses are externally driven, suspension-type cleaners. Air, steam or electric powered are available. Conventional 2-handled unit has air-control trigger. One model has single-trigger control of both air and water. This minimizes wetting of operator and working area.

Cleaners are heavy, require a supporting scaffold. Longitudinal clearance must be greater than the length of tubes being cleaned, because of shaft length. Above floor level, the operator needs a platform of equal length. Good rig is a pair of frames set perpendicular to the exchanger and farther apart than the length of the cleaner shafting. A 2½-in. pipe, laid on the frames parallel to tubes, rolls back and forth across the exchanger diameter. Shaft alignment with, and travel in and out of, tubes is quick and easy. Cleaning progresses smoothly, down-time is cut to a minimum.

Exchangers with U-tube bundles require some special handling. Free brushes, rubber plugs, etc, can't be propelled into the tubes. High-pressure water or cleaning solutions remove soft deposits. Gummy or hard deposits require scraping or cutting as in straight-tube units. Standard method is to enter each end of a tube with a flexible-shaft-driven tool and work halfway around the bend. Care is the watchword as the tool enters the bend to avoid tube-wall damage. Sometimes tubes are slightly out-of-round at the return bends—not much, but enough to bind the cutter. Best bet is to schedule cleaning while deposit is in the easily removed stage. "Clean-tube" coefficients—1.00 cleanliness factor—can be calculated. After exchanger has been operating for a while, again calculate heat-transfer coefficients. Ratio of coefficients to those for clean tubes under same operating conditions shows if cleaning is needed.

Drills and brushes are designed for all needs: (1) tool-steel drills for light, hard deposits (2) four-fluted drills—helpful, because of abundant flushing water provided, for gummy deposits (3) carbide-tipped drills for very hard, heavy deposits; this drill is the best general-purpose tool for all deposits (4) wire brushes, limited to lighter, easier-to-remove deposit, and to finish-clean after drilling.

Shafting, drills and brushes that fit both pistol grip and suspension cleaners save time on the job and eliminate need for keeping different sets of shafting in stock.

Exchangers open for cleaning should be checked for defects: faulty tube seats, bad tubes, corrosion, erosion. An accurate tube gage, proper-size expanders and some replacement tubes should be at hand. Economics may prohibit immediate replacement of a bad tube. If so, a ring and tapered plug assembly should be used to seal the tube. Ring OD matches tube ID; hole in ring matches plug taper. Assembly insures uniform expansion, prevents bell-mouthing of the tube sheet.

EDITOR'S NOTE: *For more info on cleaning heat-exchanger tubes, see Plant Problems, p 140, in this issue.*

You can stop engine knock

By PAUL D HOBSON, *State College, Pa.*

HIGH RATE of pressure rise in diesel cylinder has this effect on engine. Bearings, pistons, etc, take a very severe beating

► A KNOCKING ENGINE is irritating—can be dangerous. Rudolf Diesel's first engine knocked so badly it came apart. This rarely happens to a modern engine, but your engine's life may be shortened by pounded bearings, cracked pistons, etc, even when there's no great damage.

Nature of knock. Knock in any reciprocating internal-combustion engine means one thing: too high a rate of pressure rise in cylinder. Though high maximum pressures may accompany knock, it has nothing to do with maximum firing pressure as such. One engine may run smoothly with a maximum pressure of 1200 psi, another may knock itself to pieces at 350 psi maximum.

When pressure rise exceeds 30 psi per degree crank angle, engine knocks audibly. Anything over 50 psi per degree may cause damage. Above 80 psi per degree—damage is almost certain. This is true of any engine: diesel, gas or gasoline, 2- or 4-stroke.

Causes of knock. Basic cause is always too high a rate of pressure rise, as mentioned. One possible cause in any engine is too early ignition. Then piston is motionless, or still moving up as fuel ignites. Apart from this, causes of knock in diesels and spark-ignition engines are so different that almost everything that makes a diesel knock makes a spark-ignition engine run more smoothly, and vice versa. Dual-fuel engines are a special case. We'll deal with them later on in this article.

Main cause of most diesel knock is delay between fuel injection and its ignition. It takes time for first droplets of fuel sprayed into cylinder to ignite. During this delay more fuel enters. As soon as first particles do ignite, rest of fuel injected during delay period suddenly burns.

Ignition delay is normally between 0.002 and 0.004 seconds. If engine turns at 1000 rpm, delay of 0.002 second corresponds to 12 degrees of crank angle. With total injection period of 25 degrees, half the total fuel per stroke is in cylinder when engine fires. If delay is increased by only 0.001 second, almost three fourths of fuel goes off at once. Result is a violent pressure rise and audible knock. But high rate of pressure rise isn't needed for high firing pressures. Maximum pressure of 1000 psi can be from 500-psi compression pressure in 20 degrees, with only 25-psi-per-degree pressure rise.

Main causes of excessive ignition delay are shown at left side of chart. Let's discuss them in detail.

Low air density decreases pressures and temperatures in combustion space. It increases ignition delay and usually causes low maximum firing pressure and smoke. This may in turn be from low compression ratio, leaking valves or rings, or restriction of air flow to engine. Most frequent cause is dirty air filter, worn inlet valve-cams or inlet ports choked with dust or carbon deposit.

If a stationary engine draws air from outside, the valves, bends or size of inlet pipe may cause excessive flow restriction. At times air cannot get into engine room fast enough. This did cause failure of an emergency self-starting diesel generator in a hospital. Set performed well on test, but failed to produce power the first time it was needed when outside power failed. Only room ventilation was through fine-mesh-screen door. Years of painting had closed about 95% of the mesh-holed area. When testing, engineer always left door open. But at other times door was locked. In very rare cases the same result might occur from running a naturally aspirated engine at extreme altitude.

Low air temperature in cylinder usually accompanies low compression, but may also result from low jacket and head temperatures, or very low ambient temperatures.

Unsuitable fuel may cause knock from low cetane number. But few if any engines have trouble with otherwise suitable fuel if cetane number is

35 or better. Fuels that lack volatility or are too heavy to spray properly may cause knocking, but these usually produce excessive smoke first. Same applies to defective injection equipment.

In general, the worst natural diesel fuels come from naphthenic "West Coast" crudes. The best come from paraffinic Pennsylvania crudes. Dopes improve ignition quality, but are fairly expensive and little used. There is an approximate reciprocal relation between octane and cetane numbers. Octane of 100 corresponds to about 20 cetane, octane of 0 to about 70 cetane.

Causes of spark-ignition engine knock are shown on charts, right side. Preignition is a much commoner cause of knock in these engines than in diesels. Apart from incorrect ignition timing, glowing carbon-deposit particles in head may set off mixture. These are from dirty or unsuitable fuel, unsuitable lubricant, or too much oil passing the piston. All of these may cause heavy carbon deposit. Another possible cause of preignition is a dirty distributor, allowing current leakage across the cap. Then other plugs besides the correct one spark when points open.

Spark-ignition engine also knocks from detonation. In this engine all fuel is in cylinder throughout firing period. To have a smooth pressure rise, ignition flame must pass evenly through mixture so it doesn't all burn at once. If mixture is too hot, too dense or chemically too unstable, it burns rapidly. Trouble is that as mixture burns, unburned portion is both heated and compressed. If this process goes far enough, it ignites spontaneously, like a diesel-fuel charge—you have knock.

If mixture is compressed too much or is too hot to begin with, spontaneous ignition, or detonation, is bound to take place. The more unstable the fuel is chemically (the lower its octane number), the more easily it detonates. And the lower are the acceptable initial pressure and temperature of mixture.

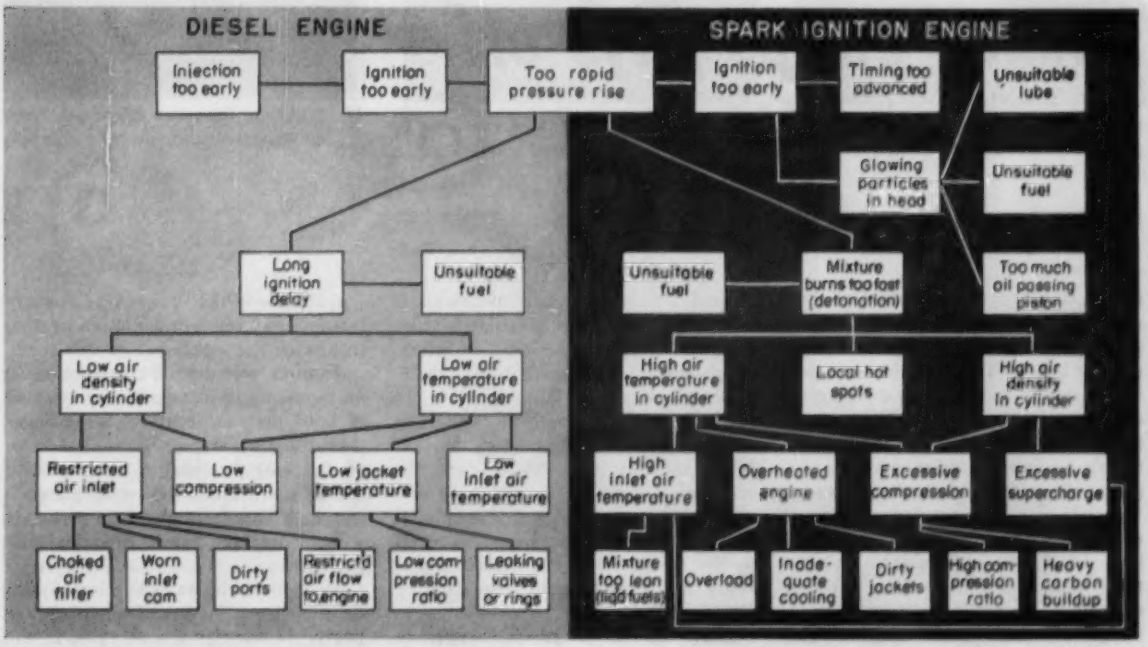
Ethyl and a few additives help. Best natural gasolines are those made from naphthenic type West Coast crudes. Engines running on liquid fuels are helped by a rich mixture. Here heat to evaporate fuel is taken from intake air, which is cooled as a result. Injecting water into the intake serves the same purpose, but more effectively. Trouble then is rapid liner wear.

Assuming fuel has right octane number, high temperature causing detonation knock may be from poor cooling. That may be due, in turn, to dirty water jackets, not enough cooling air or water flow, local hot spots (such as exhaust valve) or excessive intake-air temperature. Excessive compression from too-high compression ratio or too-heavy carbon deposit in combustion space causes both high temperature and high density, both conducive to knock. High supercharge produces same results as high compression. An overloaded and eventually overheated engine may also be expected to knock.

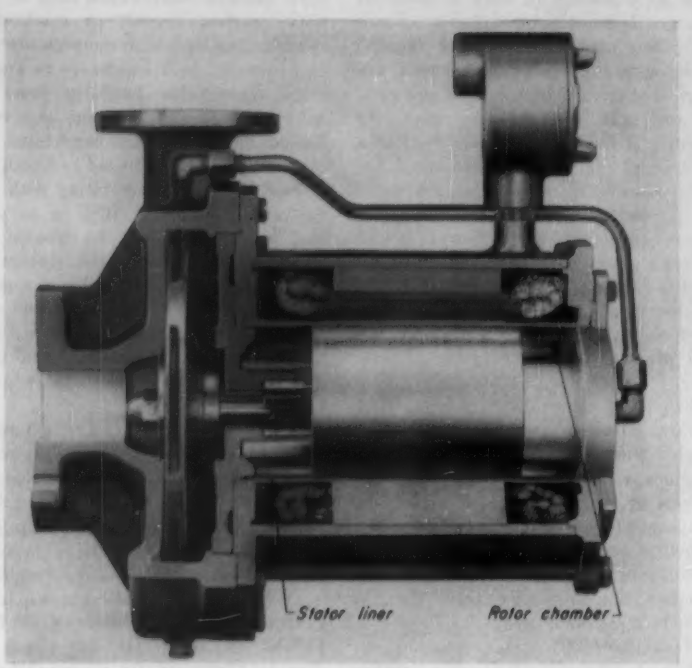
Dual-fuel engine operating with full gas supply and only 10% or so pilot fuel for ignition may be treated for knock diagnosis as a spark-ignition engine. At 100% oil fuel, it's a regular diesel engine. At intermediate positions, see if cutting off gas makes things better or worse. If worse, you have diesel knock. If better, treat as a spark-ignition engine.

Diesel engine. (1) Try retarding injection a trifle. If no improvement, put it back where it was. (2) If engine is smoking and knocking, get rid of smoke (see "Diesel Smoke," pp 120-121, POWER, Dec 1955). This often clears knock as well. (3) If exhaust is clear but engine still knocks, try a known good-grade high-cetane fuel, such as ASTM No. 1D. (4) Check engine, air filters, etc, for mechanical condition; also check for leaking valves or rings, worn cams, choked air ports, filters, etc. (5) Try putting up com-

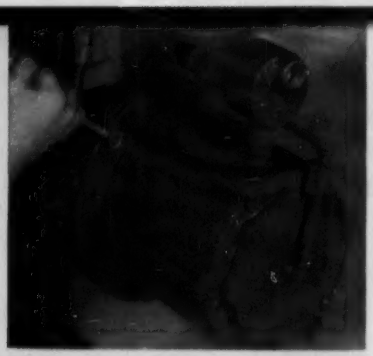
(Continued on page 208)



QUICK CHECK of items listed above will help you nail down cause of noisy engine. If pressure rise exceeds 30-psi-per-degree crank angle, the engine knocks audibly. Above 80-psi-per-degree—costly damage to your engine is almost certain



CROSS SECTION of a typical canned-motor pump, suitable for a variety of industrial services. Two-stage units of this type are also available



1 First step in pump disassembly is removal of motor from pump casing

5 Loosen all bolts holding the rear bearing housing to the pump motor

9 Withdraw the pump rotor from stator subassembly. Handle rotor carefully

Regular maintenance for canned pumps pays off

By A D FELL JR, *Chempump Corporation*

► CANNED PUMPS, also called canned-rotor or canned-motor pumps, operate without mechanical shaft seals or stuffing boxes. They require no lubrication in the sense of grease guns or oil cans. Pump and motor are built together as a single leakproof unit—there's no external drive shaft or coupling. What, then, about maintenance?

Maintenance of some parts of canned pumps is necessary. But it's a different kind from that performed on conventional packed or sealed pumps having a separate motor drive. And often canned-pump maintenance is simpler and cheaper than for other types of pumps.

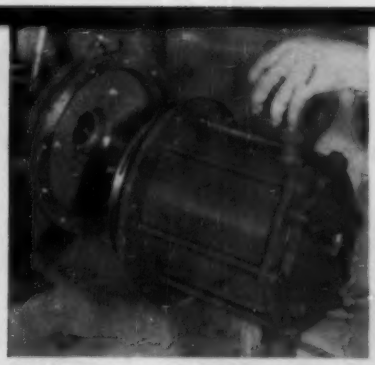
Canned-pump maintenance centers around the bearings if the design is the type shown above. Regular bearing inspection and replacement, if necessary, constitute the major steps in maintaining this type of pump.

The typical canned-motor pump, as is well known, allows part of the fluid being handled to circulate inside the motor in a chamber created by a corrosion-resistant cylindrical liner placed in the air gap of the stator. Liner is welded to the stator end bells and prevents the pumped liquid from entering the windings.

Rotor and bearings, submerged in the pumped liquid, are cooled and lubricated by it. To obtain the long service life for which canned pumps are intended, a program of routine bearing inspection is needed.

Bearing inspection. Experience based on thousands of installations shows that in most the rear bearings wear faster than the front ones. So an inspection of the rear bearing is recommended within three months after a pump is installed. This inspection is easily made without breaking pipe or electrical connections.

To inspect the rear bearing, follow these steps: (1) Shut off power to the pump. If there is a gate valve in the pump discharge, shut it first. (2) Drain the pump by removing the lowest plug



2 With all bolts loose, slide motor carefully away from the pump casing

3 Loosen left-hand nut holding the impeller in place on the rotor shaft

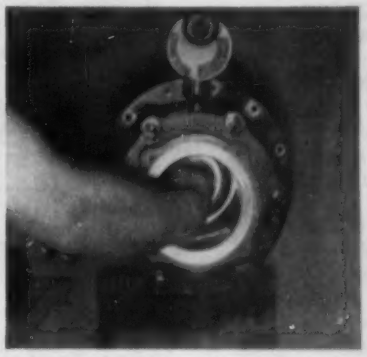
4 Draw off impeller by hand, taking care not to damage it or pump shaft

6 Use two screwdrivers to pry off the rear-bearing housing cover, as here

7 With the rear housing removed from the pump, bearing is easily reached

8 Slip the rear bearing out of the housing by hand, as is shown in photo

10 With the rotor removed from the subassembly, front bearing is seen



11 Insert your hand to remove front bearing from its housing in pump

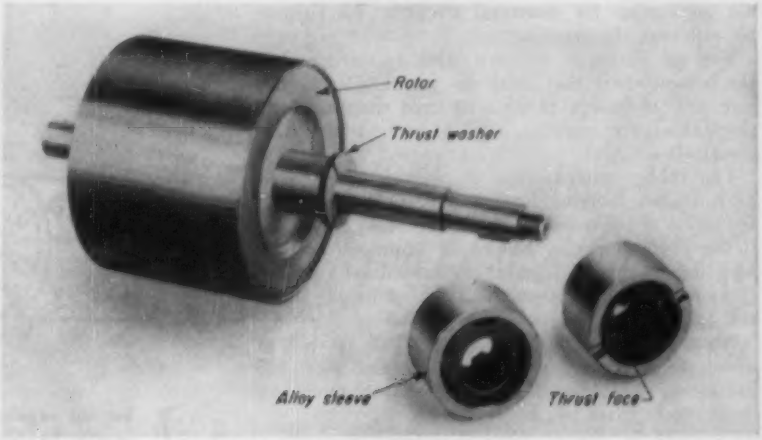
12 Front bearing, showing how it can be slipped from housing in pump

from the chamber. (3) Remove circulating tube. (4) Remove bolts holding the rear bearing housing to the end bell, Fig. 5, page 120. (5) Pry off the rear bearing housing evenly, using two screwdrivers, or similar tools, Fig. 6. (6) Slip out rear bearing, Fig. 7 and 8.

Measure the inside diameter of the bearing and compare it with the outside diameter of the shaft. If the difference is 0.013 in., or greater, the bearing must be replaced, as must the front bearing. The original or manufactured clearance is 0.003 in. on the diameter.

Thrust loads are taken on the face of the bearing, which projects beyond

(*Continued on page* 200)



13 Rotor of a typical canned-motor pump, showing the thrust washer, the front and rear bearings. Sleeve-mounted, the bearings are made of various materials

Topnotch care for conveyor belts

► A CONVEYOR BELT must be properly selected for the service, installed and maintained right. See sketches at right for a fast run-down on maintenance of rubber belts. Then read below for some of the reasons behind the suggestions.

The most common rubber belt is built around a cotton duck carcass that provides strength to withstand the developed stresses and give body to the belt so it can carry the load. Carcass may be cotton or rayon fabric, fabric and cord, or it may incorporate steel cables. There are other carcass materials for special conditions, and different types of rubber compounds to take extra punishment. Consult manufacturer for best belt for your service.

Carcass material is bonded together by so-called rubber friction. There are also thin skim coats of rubber placed between the fabric plies. These increase flexibility, help prevent ply separation, give added protection against moisture and insulate one ply from another.

A breaker of open weave fabric between carcass and top cover gives additional resistance to shock load, increases cover adhesion and prevents tearing.

The rubber cover surrounding the fabric plies is not responsible for structural strength. Its purpose is to protect the carcass.

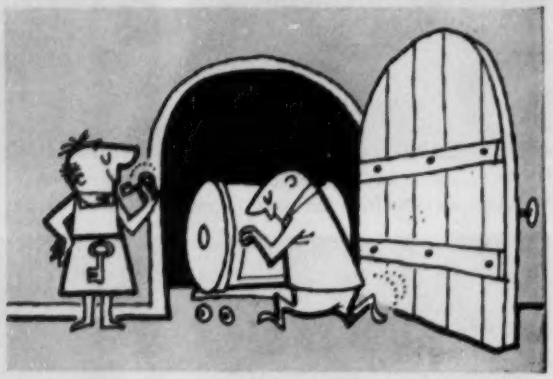
The top cover or carrying layer is thicker than the bottom cover that rides on the pulleys. Covers give belt resistance to abrasion and moisture, add shock-absorbing qualities, and protect carcass from chemicals and heat.

The rubber cover stands up indefinitely so long as it is not distorted beyond its elastic limit. But the fabric or cords are exposed to abrasion or wetting if the cover is cut or broken by improper loading, high impact, poor alignment with resultant rubbing, rocks or ice caught between pulley and belt or material caked on these surfaces, oxidation, etc.

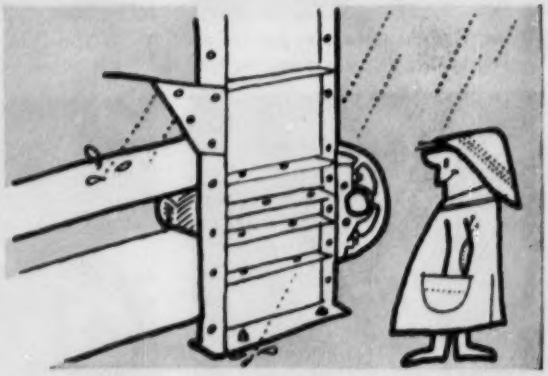
Abrasion can cut the fabric, water can cause it to shrink or mildew. Loss of capacity and shortened life result. Repairing damage immediately minimizes these effects, gives you better service.

Information and sketches for this article, courtesy of Hewitt-Robins Incorporated.

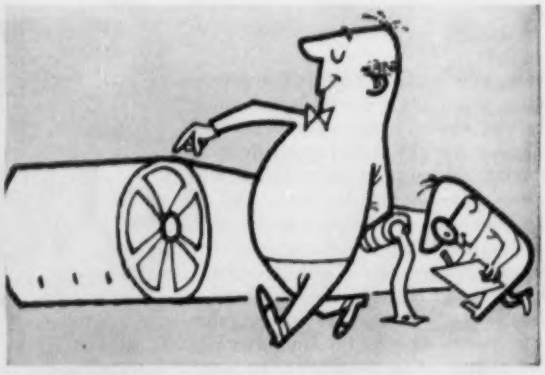
Tomorrow isn't soon enough!



1 Store belts properly. Heat, light and air increase rubber oxidation. Don't store the belts near steam pipes, radiators, hot air registers, any heat source. Ideal place is in cool dark cellar, free from moisture, heat and frost

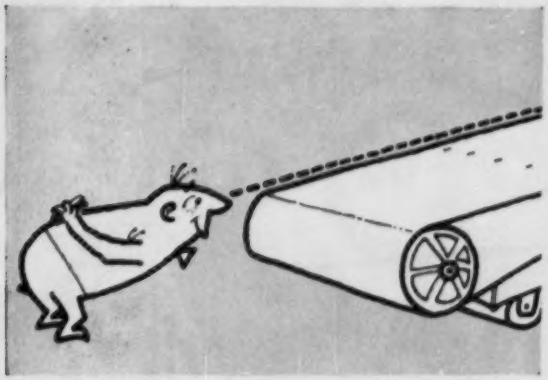


4 Lag the drive pulleys. Top-quality grooved lagging prevents pulley wear, eliminates slipping caused by water or frost. Bolted-on lagging eliminates need for carrying spare lagged pulleys and for time-consuming re-covering jobs

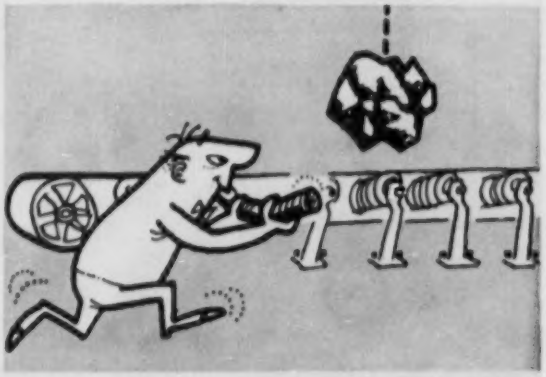


7 Set up regular inspection schedule. Check daily and weekly for belt damage, excessive wear, loose, worn or broken fasteners. Repair or correct immediately. If belt breaks at fastener joint, cut back and re-fasten properly

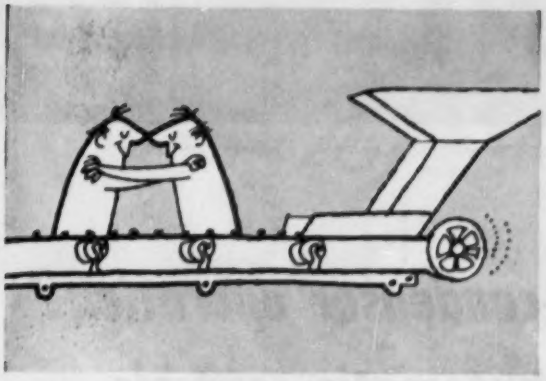
Little men show how to make your belts live longer, starting today



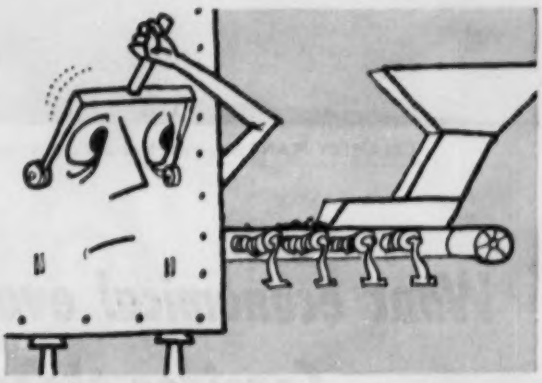
2 **Keep belt aligned.** Incorrect alignment, caused by top-sided load, idler misalignment, faulty splice, insufficient belt contact, can bring on edge wear, snagging, spillage, uneven tension. Return and troughing trainers may help



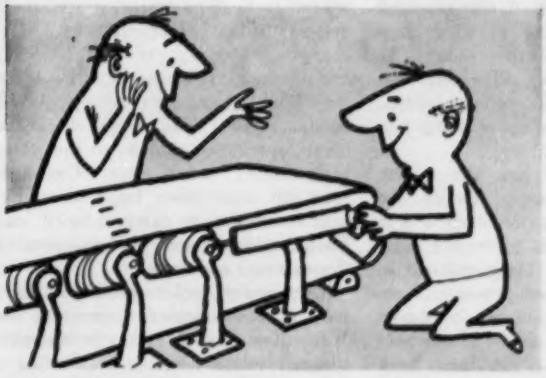
3 **Use impact idlers** to help absorb the shock at loading points. Less strain on both carcass and cover results. Record the tonnage moved and repair costs for each belt. If costs become excessive it is cheaper to put in a new belt



5 **Design loading chute** and skirt right. Correct chute minimizes impact, puts material in center of belt, at its speed and direction of travel. A good skirt is all rubber, does not touch belt; it stops spillage, shapes load

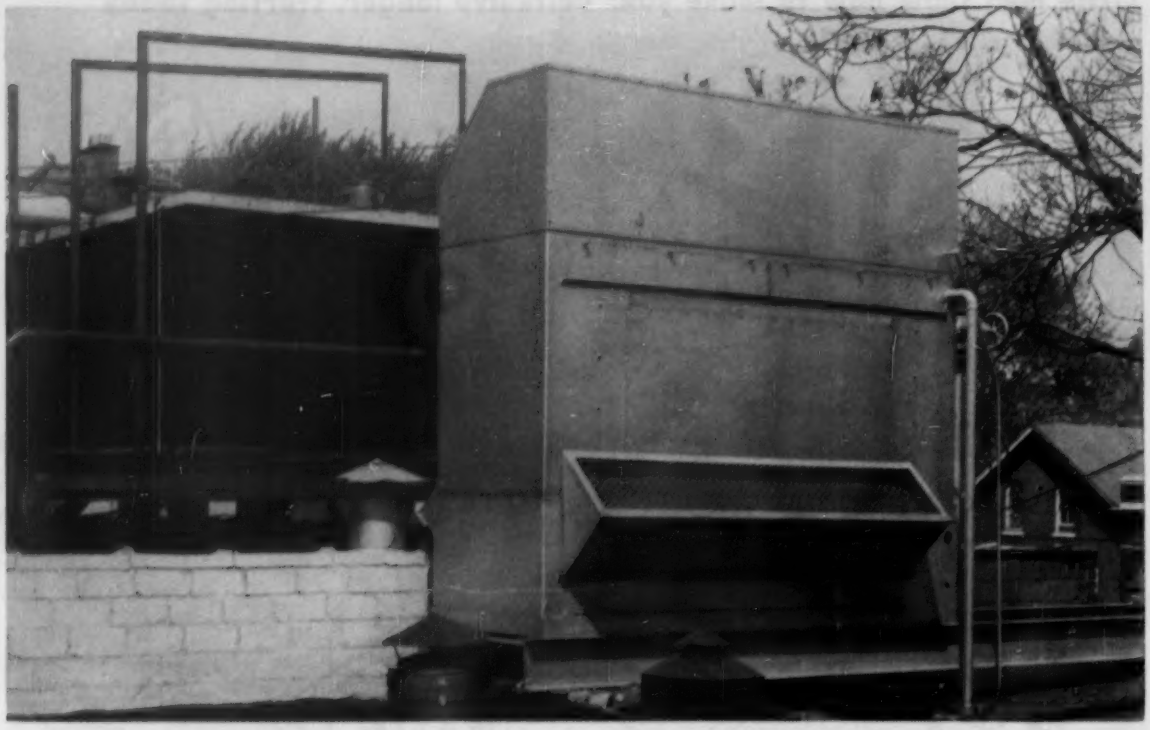


6 **Use automatic switches.** Arrange so switches automatically shut down the conveyor if (1) belting breaks (2) there is excess slipping on drive pulley or (3) feeders or chutes choke up. This will save plenty of headaches



8 **Lubricate the idlers,** but don't overdo it. Except in extremely dusty or wet areas, grease idlers only once every six months. Otherwise, you may break the grease seal and overflowing lubricant will rot the bottom cover of belt

9 **Repair damage immediately.** Unattended belt damage lets dirt and moisture attack the fabric. Impact and sliding over pulleys and idlers makes it worse. Repair by cutting out harmed spot, vulcanizing new rubber into hole



CREAMERY PLANT cuts costs by installing an automatically operated evaporative condenser on its roof

Want economical evap-condenser operation? ... Consider these automatic controls

► FACING another summer of cooling-water shortages for your refrigeration plant? You don't have to. Give some careful thought to installing a recirculated cooling-water system instead. One good way of doing it is with evaporative condensers. Then, to make sure you'll get the most for your money, operate them right.

Photo above shows an evaporative condenser mounted on the roof of the Mayfair Creamery, Buffalo, N. Y. Key feature of its economical operation: Automatic controls that respond to head pressure. Drawing, facing page, shows details of how such a system operates.

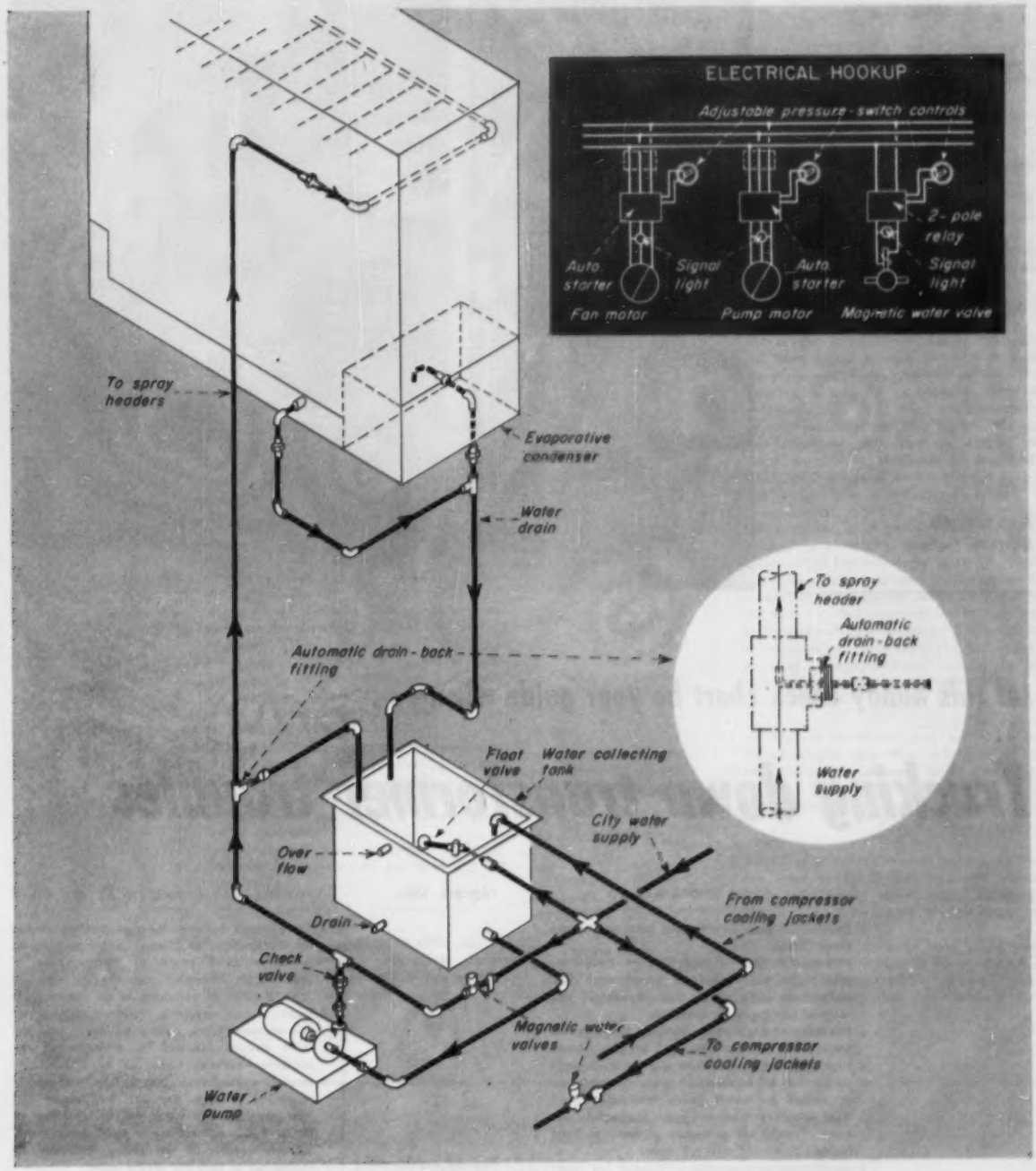
Basically, economical operation depends on using the cheapest condenser cooling medium to its fullest capacity before calling into service the next coolant. Cooling methods (listed in order of increasing costs) are (1) natural-draft air circulating through the condenser when all other supplies are cut off (2) forced-draft air supplied by the condenser fan (3) water supplied by the recirculating pump (4) normal makeup water (5) additional water supply from an outside source if the recirculating pump or pump motor is out of service.

Here, in brief, is how the system works: Fan and pump motors are equipped with automatic starters that are energized through adjustable pressure-switch controls. These respond to refrigerant-system head pressure. Pressure switch also actuates a 2-pole switch that energizes an on-off solenoid valve in the makeup-water line. Each pressure switch swings its motor or valve into service, step by step, at successively higher head pressures. And the system also cuts in an outside water supply if the recirculating pump fails, if lines clog or electricity is cut off.

By operating automatically in response to head-pressure variations, the system is, in effect, following load changes. Varying refrigerant loads and changing weather conditions call for variable condenser horsepower. If condenser heat load drops off, instruments operate to shut down the water-recirculating pump first. Continued load dip shuts down fans, allows natural convection to carry reduced load. Load buildup starts up equipment in the opposite sequence.

Compressor jacket cooling-water is part of the automatic operation too. Water flow to each jacket is controlled through solenoid valves responding to compressor temperature, yielding most efficient compressor operation. After cooling compressors, water returns to system's collecting tank.

Important operating feature: Water-



supply line to the spray headers drains automatically. So lines can't freeze up in cold weather when evap-condenser water pump is shut down.

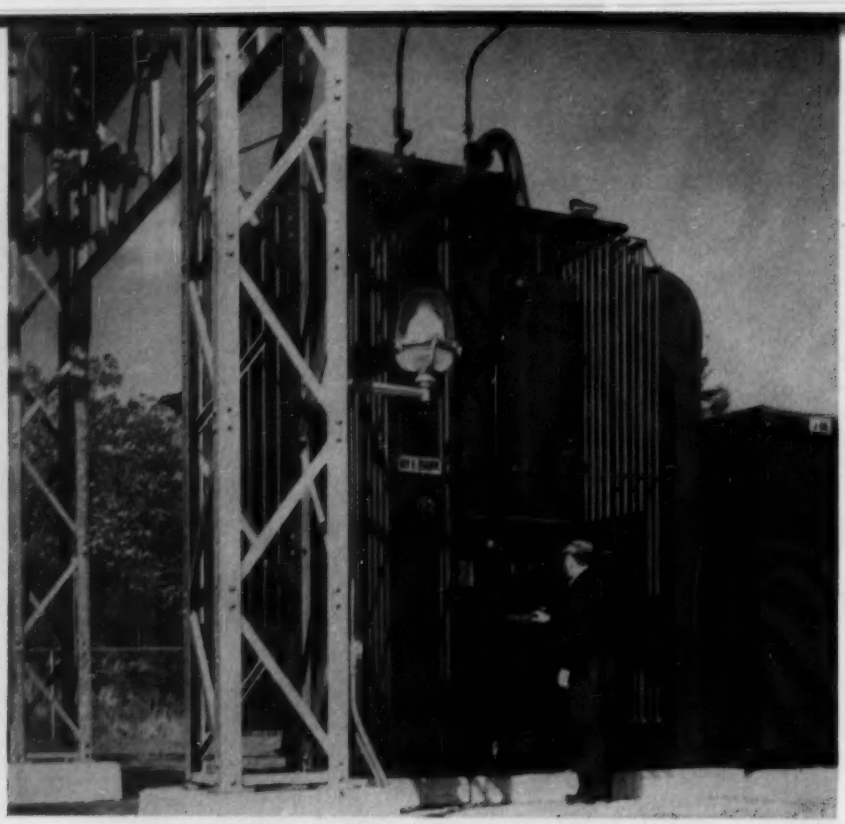
Applications. As we've seen, the weather affects all evaporative condensers. And most refrigerating plants have varying loads. Some plants—breweries, dairies, food-freezing and packing houses have big load swings. Without automatic controls in such plants, unstable condensing pressures often result. Refrigerant coils and coolers either become *flooded* or *starved*. Hand-expansion-valve or thermal-expansion-valve systems take a licking on this count. But even float controls are affected by resulting pressure difference between liquid and evaporating side of the coil.

Installing colored lights or alarms along with pressure switches tells the operator when pump and fan motors are operating and also when the emergency water valve opens.

Advantages. Automatically operated evaporative condensers save water. But, often just as important, they trim electricity and manpower costs, avoid winter freezeups. They're worth your study if you're looking for ways to improve operation this summer.

—Courtesy, Frick Co, Waynesboro, Pa.

ELECTRICITY



By S SPENCE
Cheshire, England

Let this handy check chart be your guide when . . .

Tracking down transformer troubles

TROUBLE SIGN	POSSIBLE CAUSE AND WHAT TO DO
General overheating	1 Overload is possible. *Reduce load or improve power factor* 2 Improper division of load between transformers in parallel. *Make sure transformers have same turns ratio, percentage impedance, and ratio of resistance to reactance* 3 Unbalanced single-phase loading of polyphase transformer. *Redistribute load between phases* 4 High ambient temperature due to inadequate ventilation of transformer area. *Improve air circulation or install forced ventilation* 5 Heat absorbed from adjacent equipment. *Relocate transformer or source of heat, or build insulating barrier between them.* 6 Insufficient cooling liquid. *Check for leaks or cracks in tank and fill to proper level* 7 Sludge in the cooling ducts or on the windings. *Clean thoroughly by spraying with coolant liquid under pressure* 8 Defective pump where transformer liquid is force circulated 9 Air ducts of forced air-cooled transformer plugged by dust deposits 10 Defective watercooling system in watercooled transformers. *Check that water supply is adequate and reliable, that circulating pumps are functioning properly, and that tubes in transformer and radiator are not obstructed by deposits* 11 Power losses in core increased by deterioration of lamination insulation. *Requires dismantling core to reinsulate it, which usually means rewinding transformer*
General overheating and breakdown indications (confirmed by voltage radio test)	1 Short circuit between turns of winding caused by sharp edges of copper conductor piercing insulation as a result of vibration, or of shock from excessive currents of external short circuits or switching in on heavy loads 2 Short circuit resulting from dislodging of one or more turns, caused by heavy external short circuit, followed by abrasion of the insulation between turns. 3 Insulation breakdown due to moisture. *After repair of damage, dry out transformer and test insulation. Test the oil for presence of moisture. Check for place of moisture entrance, through gaskets or breathers, including effectiveness of breather drying agent.* 4 Deterioration and breakdown of insulation by corona in very high-voltage transformers. Corona may occur around sharp edges or corners of conductors, especially if air is trapped in part of the winding. *After repair and test, refill with oil, being careful to prevent air pockets forming* 5 Pounding of insulation as result of rapidly fluctuating heavy load with consequent expansion and contraction of conductors and varying mechanical pressure on the insulation. *Reinsulate damaged winding, securing coils to prevent vibration. If possible, change load to reduce fluctuations* 6 Insulation breakdown caused by line surges and lightning. *Better protective equipment, such as reactors and lightning arresters, should be considered*

TROUBLE SIGN	POSSIBLE CAUSE AND WHAT TO DO
General overheating without load on Y-Y transformers	1 Increased core loss caused by distortion of transformer's magnetic circuit as result of grounding only secondary neutral. *Condition can be corrected by employing delta-connected tertiary winding on transformer. Use of underground secondary may reduce core loss, but may lead to unbalanced phase voltages. Best practice is to avoid Y-Y connections where possible*
Unequal heating in Y-Y connected bank with grounded neutral	1 Ground fault exists on one phase as result of insulation failure, either inside transformer or somewhere on external circuit. *Disconnect bank and find where ground fault is located. After repairing ground fault, give insulation test to each transformer in bank*
Unequal heating in Y-Δ connected bank	1 Ground fault on one of the primary phases due to insulation failure, either internally or externally. *Disconnect the bank, locate and repair ground fault*
Low insulation resistance	1 General overheating, caused as described on facing page, results in deterioration of insulation 2 Moisture. *Drain oil and dry out windings, and test again. Check oil for moisture content; if moisture content is high, recondition oil or replace it. Examine tank, conservator and radiators for possible place of entrance of moisture* 3 Insulation weakened by line surges or lightning. *Repair insulation if damage is localized, or rewind or replace transformer. Consider installing better protective equipment to prevent recurrence* 4 Shifting of conductors caused by mechanical shock resulting from excessive currents of external short circuits or switching of heavy loads. *Replace coils in proper location, reinsulating where necessary, and secure against further movement* 5 End-turn insulation not adequately reinforced. *Reinforce insulation on oil end turns and test windings again*
Output voltage too high or too low	1 Leads connected to the wrong ratio taps, or tapping links incorrectly positioned. *Reconnect the leads or reposition the tapping links to make correct connections*

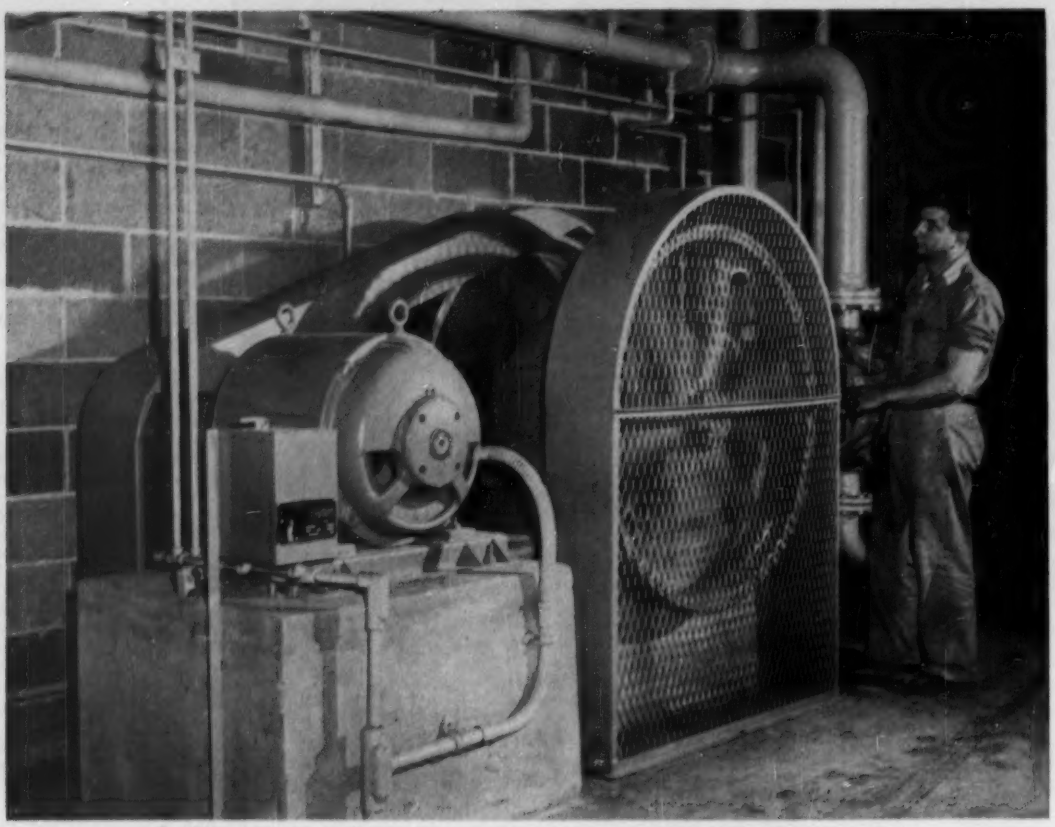
TROUBLE SIGN	POSSIBLE CAUSE AND WHAT TO DO
Localized overheating	1 Eddy current losses in the core caused by breakdown of bolt insulation, probably due to vibration. *Reinsulate the bolts and secure insulation to prevent vibration* 2 Deterioration of insulation between laminations. Reinsulate part of core affected. *General condition of core, as well as extent of dismantling necessary, usually makes rebuilding of entire transformer advisable* 3 Breakdown of insulation between yoke and yoke clamping plates. *Reinsulate and secure to prevent vibration* 4 Eddy current losses caused by short circuits between burred-over edges of laminations. *Carefully remove burrs across laminations*
Protective alarm indicates gas in tank	1 Test of gas sample shows gas is flammable and when passed through silver-nitrate solution white precipitate is formed, showing that acetylene is present. Acetylene is given off by breakdown of oil or other insulation caused by development of internal fault. *Take the transformer out of service for detailed internal examination and tests to locate the fault before it causes serious damage* 2 Test of gas sample indicates it is air. If air is present regularly after unit is first put in service, it is probably air trapped in windings or circulating system that is being driven off as transformer warms up. *To avoid such false alarms it is advisable to excite the transformer for a period before switching on the load.* Another cause of air in tank may be from ingress into circulatory system caused by excessive suction. *Reduce the suction head by using a larger-diameter pipe, or by increasing the height of the conservator*
Protective alarm indicates vacuum in tank	1 Oil level in conservator tank has fallen below conservator pipe. *Test sample of oil and refill conservator to proper level. Check tank for leaks that may be responsible for loss of oil to prevent recurrence*
Unequal phase voltages in 3-phase bank	1 Ground fault (either internal or external) on one phase of wye-to-delta connected 3-phase bank. *Locate and repair ground fault, and test insulation resistance of transformer to avoid recurrence* 2 One transformer connected with polarity opposite to that of others in bank. *Determine correct polarity connections of transformers (additive or subtractive) and reconnect them*

Can transformer oil dielectric tests be improved?

Dielectric test is the most important check on condition of oil in your transformers. For years, standard gap test prescribed by the American Society for Testing Materials has been used. Recently, however, it has come under close scrutiny because of exacting demands of modern transformer design. Standard test places oil in cup in which are two disk terminals, one inch in diameter and spaced exactly 1/10 inch apart: 60-cycle voltage is applied across gap; voltage is then increased in steps until oil breaks down in gap. An average breakdown voltage is determined from several tests. Oil in service should have a breakdown voltage of at least 22,000 volts; new oil may test as high as 30,000 volts.

Recent research into effects of shape and area of electrodes indicates that much more accurate results can be obtained than with standard gap. Modified hemispheric electrodes designed to produce uniform electric field in gap have been developed by the General Electric Company. They will recommend adoption by the American Society for Testing Materials.

More reliable checks on your transformer oil are provided by new gaps. Since transformer oil needs good care to prevent the formation of sludge, acids and explosive gases, and to keep down moisture absorption, regular tests for dielectric strength are a must.



1 Horizontal motor-driven air compressors have long been popular in all kinds of industrial plants. This unit is carefully installed and piped. Note wheel guard

For sweet-running air compressors,

► YOUR NEXT AIR COMPRESSOR may well be a horizontal unit, especially where plant floor space isn't cramped. But let's get one point straight right now—horizontals aren't any better than verticals—they're both good. You use one instead of the other because job conditions make that type the better choice. Both have advantages, and disadvantages.

Why horizontal? Compressors having their cylinder center line parallel to the floor are called horizontal units. A number of different designs are shown on these two pages.

From the operating standpoint, horizontal compressors have a number of advantages. These include easy installation—see Fig. 2. The foundation required is usually a simple block without extensive footings. You can build the forms and pour the concrete yourself, provided you follow the manufacturer's drawings and instructions carefully. Usually, though, it's best to have a consulting engineer inspect the foundation drawings and site to make any necessary recommendations before actual construction of the foundation begins.

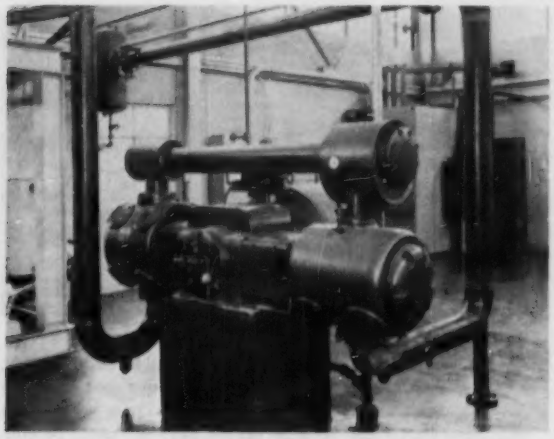
Piping connections are simple, too. Suction and discharge lines can be run to and from the compressor with few bends. Drains must be provided at the bottom of loops and other points where moisture might accumulate. Your safest bet is to follow the manufacturer's piping recommendations exactly. Then you'll be sure the unit will work right.

Suitable drives for horizontal compressors include electric motors, steam engines and turbines, internal-combustion engines and gas turbines. Direct-connected motors, Fig. 2, are popular because they are compact and save floor space. Belted drives, Fig. 1, are common because they permit operating the motor and compressor at their best speed.

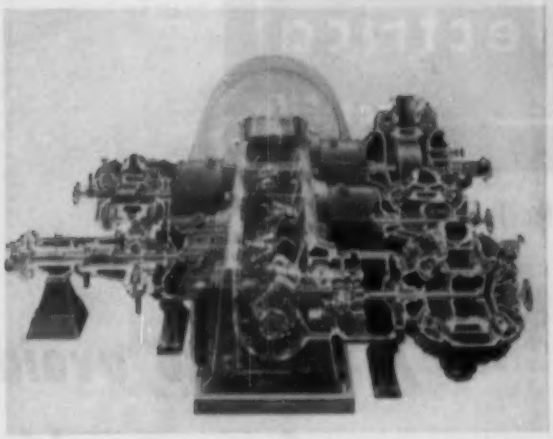
Operation. Horizontal compressors run smoothly without excessive noise if they're installed correctly and given routine attention. Items you shouldn't overlook include lubrication, inter- and after-cooler cooling-water supply, cylinder cooling, receiver drainage, pipe cleanliness, etc.

Correct lube oil is extremely important—the wrong oil can cause a buildup of carbon that may ignite, leading to a serious explosion. So play safe—use the lube oil recommended by the manufacturer; keep all pipes and valves clean; avoid compressor overheating.

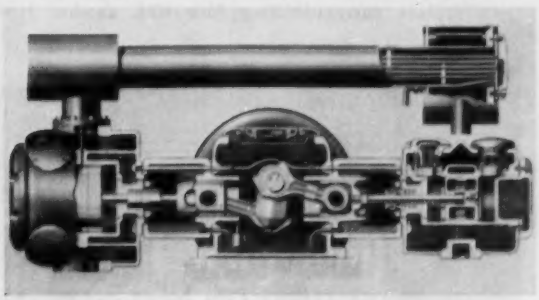
Don't overlubricate any part of an air compressor. Besides being wasteful it may lead to vaporization of the oil.



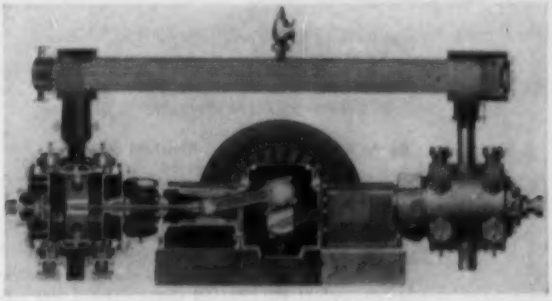
2 Heavy-duty packaged air compressor designed for 75 to 100 psi service is an opposed-cylinder balanced-design unit



3 Multistage multicylinder opposed compressor is built for high pressures. Note the easy access to the air valves



4 Cross section through the compressor in Fig. 2, showing compact arrangement and direct-connected induction motor



5 Large-capacity opposed-cylinder compressor with intercooler mounted above. Four-cylinder units are also built

switch to routine maintenance methods

forming a combustible mixture. If discharge valves leak, the resulting high air temperature may ignite mixture.

Check mechanical lubricators regularly to see that oil is delivered to the point intended. Where unit is splash lubricated, check the oil level. It shouldn't be too high—this causes foaming and oil waste. If level is too low, lube flow to compressor is reduced.

Cooling water won't give trouble if it's clean, soft and free of solids and is supplied to the compressor in the right quantities. So see to it that the water is clean—a strainer is a big help. Also, since the water's job is to reduce the cylinder temperature, it should be cool before it reaches the compressor. Regulate water flow on the compressor inlet side. Fit a sight funnel on the discharge so you can check water flow easily. With many 2-stage horizontal units an outlet water temperature of 100 to 120 F is considered good.

Plate-type valves are popular in horizontal compressors. Their worst enemies are carbon and dirt deposits. Many leaky valves are dirty and there's no excuse for it. Recompression of air that leaks back into the cylinder can cause serious fires. Check valves every 60 days, or oftener if possible. Letting valves go until they break never pays.

Drain inter- and after-coolers, receivers and moisture traps regularly. Note that moisture accumulation is greater in warm weather, when humidity is high. Test safety valves once a week to see that they pop at the right pressure. Clean the compressor, its drive and connected piping every day. You're more likely to find trouble in a clean compressor than in a dirty unit whose parts you can't see.

Spare parts. Keep enough on hand—a set of valves, bearings, packing, etc. Then your shutdown time will be a minimum when these parts need replacement. Lastly, keep a log of compressor operation, inspection and maintenance. It's a big help.

Low Air Pressure

can be expensive. Compressed Air and Gas Institute says raising the pressure from 70 to the correct level, 90 psi, saves $66.51 a day, or about $16,000 a year in one plant. Some of your biggest savings in air power can be made by using right pressure.

Plant

Electrical

Fact File

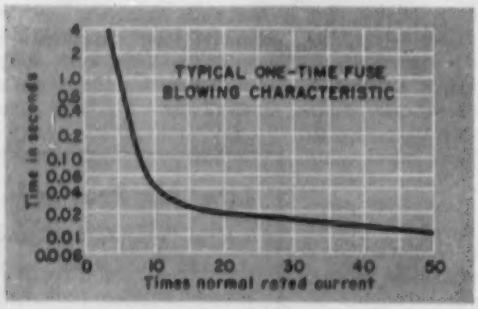
No. 1: FUSES

7 ways to avoid fuse trouble

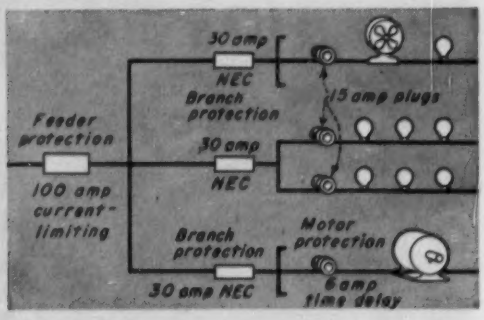
By NORMAN PEACH, *Assistant Editor*

A NEW POWER FEATURE: To help you, Mr Plant Engineer, trim back the cost of electrical maintenance, POWER is starting a series on electrical field-tested ideas. You'll get tips on improving operation, maintenance, trouble shooting, safety. Coming: practical induction-motor hookups . . . smart approach to transformer maintenance . . . dollar-saving ideas on fluorescent lighting . . . why the *right* motor-starting method keeps you out of hot water.

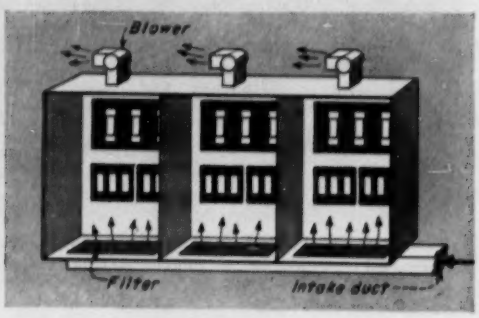
Let's hear your ideas for future pages in the Plant Electrical Fact File.



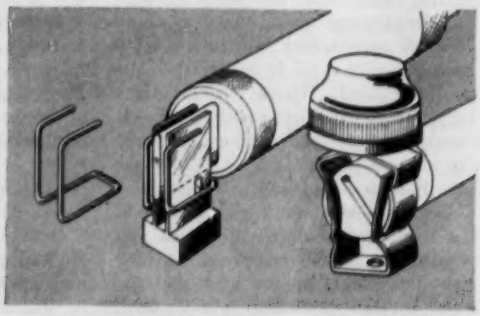
1 UNDERSTAND THE FUSE. Fuse protects circuit by melting when critical temperature is exceeded. Ambient temperature affects fuse as well as heat caused by current. Fuses have inverse time characteristic: blowing quickly on large currents, more slowly on currents just above common rating.



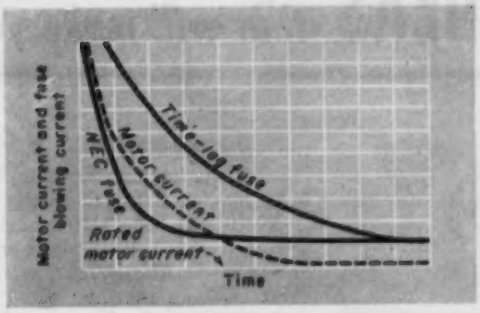
2 PICK THE RIGHT FUSE. Many types fuses are made, see sketches, facing page. Be sure you're using fuse that gives best protection in spot where you need it. Current-interrupting capacity must be considered with respect to maximum possible short-circuit current. Current-limiting fuse cuts off short-circuit current before it reaches maximum. Never replace current-limiting fuse with another type.



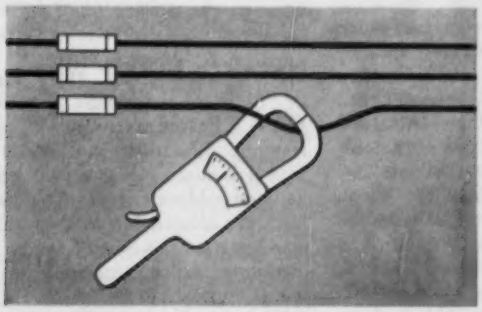
3 WATCH AMBIENT TEMPERATURE. Maybe somebody installed a new steam line without considering a nearby fuse panel, and the fuse temperature is pushed up near the critical point. A short-time overload that the fuse normally would carry now blows it. If fuse panels are located where high ambients are unavoidable, ventilation of these panels should be considered as possible remedy.



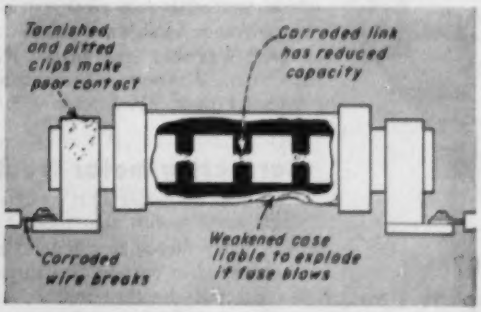
4 GOOD CONTACT IS A MUST. Polish or replace burned or dirty fuse clips. Be sure contact surfaces are bright before replacing renewable fuses. Links of renewable fuses must be fastened tightly in place. If fuse clips lose tension, but contact surface is still good, use tension clamps or clips as shown.



5 **PROVIDE FOR HIGH CURRENTS** that occur when motors start. Fuse that normally carries inrush current may blow if two motors are started at same time, or if machine drive is sluggish accelerating. Time-delay fuses are usually the answer to this problem. Controls can be interlocked to prevent two motors starting simultaneously. Where this arrangement is practical, load on fuse is kept down.



6 **CLAMP METER CHECKS LOADS REGULARLY.** Handy instrument makes it easy to know which fuses are carrying the load, and redistribute some of it before fuses start popping. Additional lights or plugged-in machines may have been added to a heavily loaded line while a lightly loaded line is nearby. Clamp ammeter is also useful for checking motors for possible overload or shorted windings.


Tarnished and pitted clips make poor contact
Corroded link has reduced capacity
Corroded wire breaks
Weakened case liable to explode if fuse blows

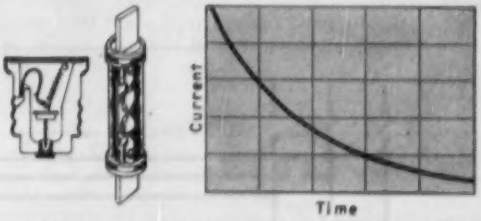
7 **PROTECT FROM CORROSIVE FUMES.** Corrosive contaminants in the air may be quietly chewing away on fuses and fuse clips, even penetrating to the link in fuses that are not powder-filled. If not possible to relocate panel, sealed covers and regular inspection help keep ahead of trouble.

Fuses designed for today's industrial plants

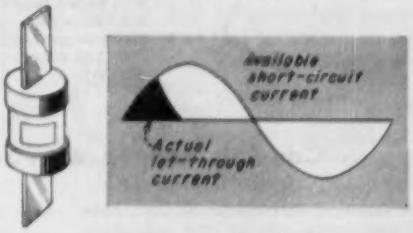
PLUG FUSES. Available in sizes up to 30 amp, 125 volts. Intended for quick, safe replacement by unskilled personnel. Type S (tamperproof) bases are made, each keyed to a certain ampere rating. An adapter enables you to use them in Edison-base fuse holder in which the adapter locks permanently.

CARTRIDGE FUSES. Ratings through 60 amp have ferrule ends, 70 through 600 amp have knifeblade ends. Fuse case is usually filled with powder to help extinguish arc and cool the fuse.

RENEWABLE FUSES. Modified cartridge fuse lets you replace blown link, save rest. Usually not designed with arc-extinguishing powder, but links enclosed in powder-filled tubes are made.



TIME-LAG FUSES. Have considerable time delay before blowing on overloads up to 500%; blow quickly on short circuit. Primarily for motor protection. Permit use of smaller fuses, switches.



CURRENT-LIMITING FUSES. Fast-acting fuse cuts off short-circuit current before it can rise above a certain value. Functions in quarter-cycle or less. Protects circuits where low impedance would make very large short-circuit currents a danger.

Today's PRACTICAL IDEAS that will make your

Now, 'ferris wheel' washes our air filters quickly

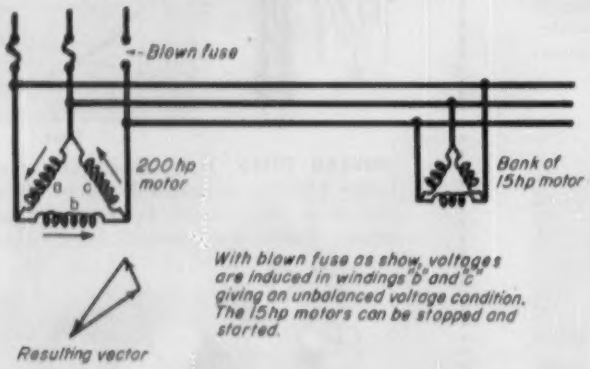
Washing air filters for our large hotel air-conditioning system has always been a slow job. Recently I designed a washer, photos, to speed the job along.

Welded tank is 24 in. wide, 25 in. deep, 58 in. long. Filter wheel is made of 2¼x1-in. channel irons, driven by two V belts through a reducer. Driving motor is ½-hp unit. Oakite solution in bottom of tank is heated by a ¾-in. looped steam line.

Eight filters are loaded onto the wheel at one time by sliding them in from the end. By revolving through the solution slowly, the filters are now cleaned much quicker because they are agitated through the solution. Job of loading and unloading wheel is also easier than piling the screens into the solution and fishing them out later. Now screens are drained of solution by the time mechanic removes them from the wheel.

Not only that—ferris wheel is loaded and mechanic goes about his work in plant. Next time he gets near tank he stops motor, unloads and loads wheel, starts motor, and goes about his business

P SVALYA *Detroit, Mich.*


Blown fuse
200 hp motor
a
b
c
Bank of 15hp motor
With blown fuse as show, voltages are induced in windings "b" and "c" giving an unbalanced voltage condition. The 15hp motors can be stopped and started.
Resulting vector

Can this happen with 3-phase motor?

How many of you electrical boys have run into this problem? I'll concede a 3-phase motor won't start from rest on single phase, or when one fuse is blown. But, when several small motors are combined with and fed from the same circuit feeding a large motor, you can stop and start the small motors with one fuse blown on main circuit.

Condition is brought about from "transformer effect" and feed backs from large motor. It's very deceptive unless you check voltage accurately. I lived with this condition for about two weeks before finding the trouble.

Something haywire is first shown by fuses blowing on small motors. But trouble is that many shift electricians, to keep things running, calmly proceed to overfuse. Also, most electricians check 550-volt circuits with small pocket-size "wigglers" or "neon" testers. Such testers indicate there's voltage on all three legs, but not its true value, nor that it's badly unbalanced. Fact is, it isn't a 3-phase voltage at all.

Sketch shows a typical hookup that caused such a condition. Your best bet when trouble-shooting a fault of this kind is to use an honest-to-goodness voltmeter. That's what put me wise.

L MCWILLIAMS *Shawinigan Falls, Q.*

Here's a better way . . .

In "trick" of the month, Oct 1955, p 137, G P Pearce saves water pipes from freezing. His plant has outside shed with a lavatory. During cold weather, hot- and cold-water pipes froze because heat was unavailable in shed. Electrician installed two 25-watt lamps and a thermostat, which energizes lamps when temperature drops below 40 F.

His method is good. I suggest using electric strip heaters. These units come in a variety of sizes for different heat outputs and are well suited to this type of application. Strip heaters offer advantages of safety from broken glass and electric short circuits if wires are broken or get wet. Strip heaters may be furnished with thermostatic controls that will adjust current according to heating needs. Although Pearce's lamp-bulb method is less costly, strip heaters are more reliable and safer.

H B WAYNE *Brooklyn, N. Y.*

ED. NOTE: *For more info on strip heaters see* POWER, *April '55, p 130.*

Correcting motor trouble

Plant had hot-water unit heaters with single-phase motors that rotated clockwise. They turned in counterclockwise direction when current was turned on. We checked the throw-out collar and starting switch to see if motors were stuck in open position. These motors will try to run on running winding only. Sometimes motors won't rotate, but will hum. To remedy, we free the throw-out collar, clean starting-switch points.

R CASTELLI *Spring Valley, Ill.*

power services flow more smoothly

STEVE ELONKA, *Associate Editor*

Here's how we wash turbine blading

Start four hours before turbine is expected to be on the line for handling load:

(1) Start auxiliary oil pump and circulating pump as usual, but leave evactors off. (2) Open ¾-in. bypass around 10-in. header valve, then open header valve halfway. (3) Open throttle valve as usual to get turbine rolling, then close throttle valve. (4) Close 10-in. gate valve, leaving ¾-in. bypass open.

(5) Open throttle valve wide. (6) Set inlet valves so only No. 1 is open. (7) Connect washing hose and start condensate into connection under superheat thermometer. (8) Close drain valves on lower U bends. (9) Let hotwell fill up three times, start condensate pump and empty each time it fills. (10) During last filling of hotwell, open and close all three inlet valves to expose the full length of all valves to washing action of wet steam. Also trip throttle and reopen it. Repeat both of these operations two or three times. (11) When third hotwell full has been pumped out, close throttle tightly, build up pressure ahead of it to 400 psi, then open 10-in. gate valve. (12) Start up in usual way; bring turbine up to speed and synchronize.

If you run short of condensate while washing blading, pinch down on condensate flow from other turbine to steam-generator plant.

Be especially careful about these two things: (1) Make sure 400-psi pressure is equalized across the 10-in. header valve before trying to open or close it. (2) Be sure all three lower U-bend drains are opened and all water drained out of them before you bring the turbine up to speed.

A C STOEVER *Granite City, Ill.*

EDITOR'S NOTE: *Do you have a "lighting-off sheet" like this to help your operators? It insures following right sequence and, besides, avoids pulling some man-size boners in your plant.*

Did you know . . .

that if you increase conveyor speeds in drying ovens you must increase your ventilation? If not, the more rapid formation of flammable vapors might result in an explosive mixture.

What would you have done?

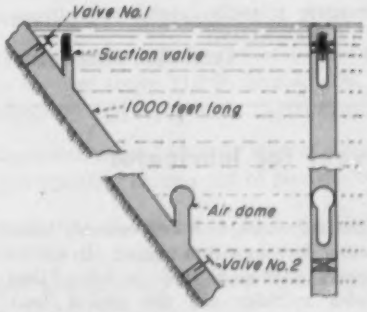
When our vessel was three days from port, I was faced with the fact, as chief engineer, that losing one hour of running time could mean losing 24 hours in port. That would be costly for the company. Headaches started when turbine-oil line began leaking badly. This line was directly against the tank top (tank tops of double bottoms are under engine-room floor plates). We couldn't put a temporary patch between pipe and tank. Also, we couldn't determine extent of defective 4-in. pipe.

I could shut down for a couple of hours, but that lost time would get us into port late, be expensive. Instead, I made a quick estimate of leakage; then we cleaned and dammed off a 10-ft area of tank top and hooked up the oil-purifier suction line. We'd lose about 1000 gal of oil, my complete storage supply.

We built an L-shaped dam. Ship's side and gusset formed the other two sides. One end was made between two beams. The 2x10-in. timbers were secured between two vertical beams with about a 10-in. space between. We calked inside this form with rags, cleaned space and poured cement. Dam's other section was made of 2x10-in. timbers running under and around piping. After insides around piping and joints were calked with rags and cleaned out, cement was poured. Oil was contained in the dam, ready to centrifuge.

Men had right spirit and pitched in. Everyone got thoroughly soaked with oil, but when salvaged it proved OK for reuse. We made port on time and I was commended for my action. What would *you* have done?

Z H WRIGHT JR *Kingston, Tenn.*



Don't forget vacuum breaker

Penstock is subject to collapse when not provided with vacuum breaker. Also, water hammer is often noticeable in hydro turbines if penstock doesn't have air dome at lowest part, sketch.

New hydroelectric turbine was ready to start. Penstock was filled with water and valves shown were closed. Then as turbine was prepared for trial, valve No. 2 was opened instead of valve No. 1. Sudden flow of water into penstock, with head of over 1000 feet, created a high vacuum. Penstock's upper part below valve No. 1 collapsed.

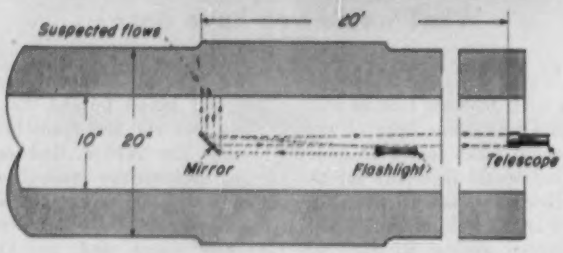
To prevent this headache, install a vacuum breaker with calibrated spring, as shown, to permit air entering when high vacuum is created. I also recommend an air dome of required volume, at lowest part of the penstock. This prevents water hammer and possibly bursting of the penstock if sudden obstruction occurs on lowest part.

A CAMACHO *Cebu City, P. I.*

(*Continued on page* 134)

More PRACTICAL IDEAS

Begins on page 132



Now we look *inside* hollow shafts

When the 21¾-in.-diameter shaft on an old horizontal generator broke, we naturally got worried about the shafts on other 40-year-old units. But question was how to inspect them?

Photograph shows location of failure, close to rotor hub at inboard bearing position. Note feeler stuck into crack. Sketch shows how we make preliminary visual inspections now.

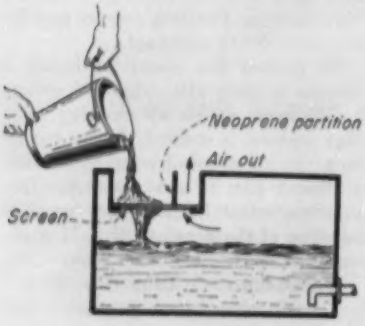
Prism, or mirror, from an amateur astronomer's reflecting telescope is mounted at a 45-degree angle on a long stick, sketch. Focusing flashlight is placed to bring a beam of light to project on the mirror, then to the portion of shaft under suspicion. By focusing a 32-power telescope (from a surveyor's level) at about 20 feet from mirror, view carried by return rays of light is picked up.

Definition is extremely good, as we can observe tool marks, boring-bar marks—and, unfortunately, evidence of what may be a developing failure. These are hairline faults where oil was oozing through the minute criss-cross lines, indicating fatigue—crystallization.

Later checks with X Ray and magnaflux failed to prove conclusively that a failure is actually developing, but we're keeping our fingers crossed. This telescope idea might save other POWER readers a costly breakdown.

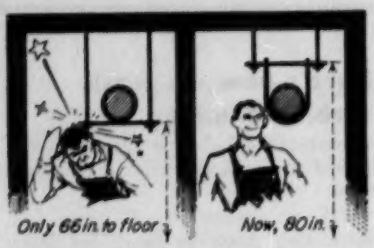
L McWILLIAMS
Shawinigan Falls, Que.

Neoprene makes air vent for lubricator



Designer muffed on new cylinder lubricator for our steam engine. It has no opening for air to vent. So when filling with cylinder oil, air gushes back through oil. I placed a piece of heavy neoprene in the filling recess to partition the opening, sketch. Now one section is free to vent air while oil is poured into other section. This solution was much easier than drilling lubricator casing for an air vent at other end.

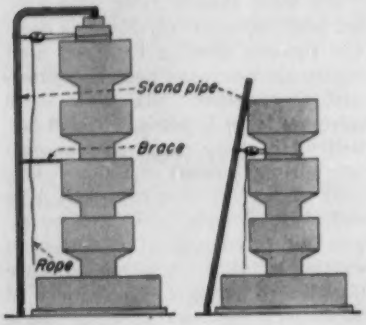
J BAUER *Chicago, Ill.*



No goose eggs now

We rearranged piping and hangers in our pipe tunnel because our men were getting goose eggs on their noggins, sketch. No more swelled heads now.

S H KRONE *Canby, Minn.*



Safe way to tear down equipment

I was faced with problem of tearing down a cooling tower that had a 12-in.-diameter standpipe running up over the tower's top. Problem was to get standpipe down safely. I couldn't lift the pipe with a crane.

Problem was solved by first putting a line on the standpipe near the top. Rope fall, sketch, was attached so pipe could be pulled into cooling tower. Next step was to cut a section out of pipe near tower; next, we cut our brace. Wedge-shaped piece was then cut out of pipe near ground on tower side so we could pull pipe over against tower.

As each section of cooling tower was removed, we cut off same length of pipe and threw over side with rest of tower.

R P BLAND *Ventura, Calif.*

Try silicone grease

We had a tough time removing burned-out infrared lamps in our processing ovens. Trouble came from extreme heat that literally baked the lamp bases into the sockets. We licked the problem by coating silicone grease to each new lamp base screwed into socket.

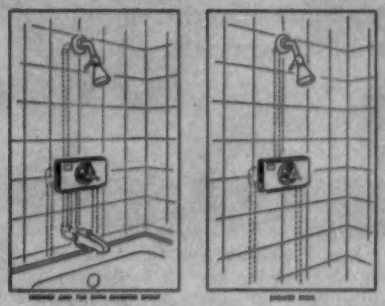
W WILSON *San Francisco, Calif.*

(*Continued on page* 136)

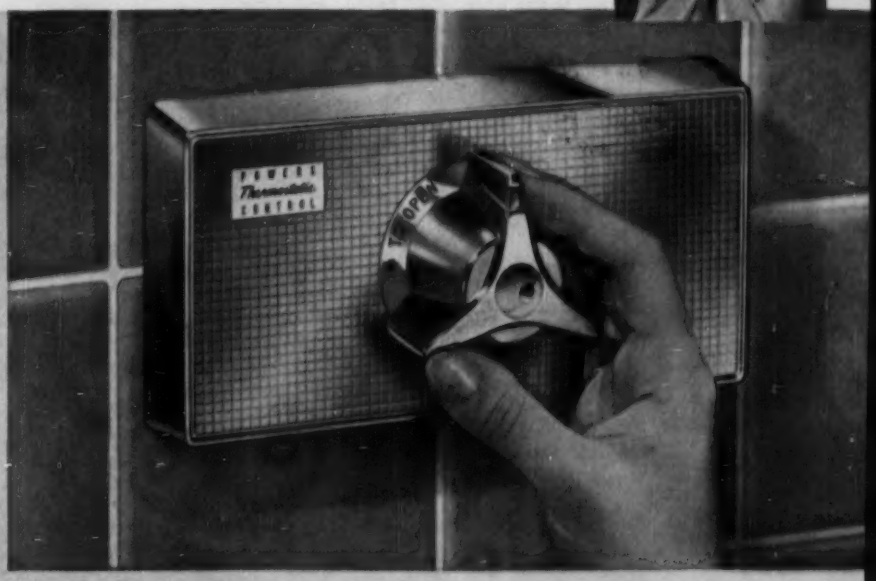
POWERS

NEW Hydroguard®

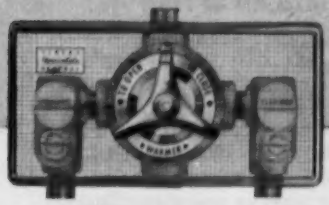
Best Insurance for SAFE, Comfortable Showers!



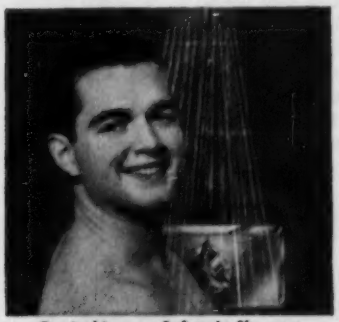
More Convenient for Bathers
HYDROGUARD installations are uncluttered with various valves. Because it has a built-in *shut-off valve* none is required between it and the shower head. HYDROGUARD is often used with shower heads having built-in *volume control*. For shower and tub control it is used with diverter spout as shown above.



HYDROGUARD introduces an advanced style trend in shower control. It provides greater convenience for bathers and neater appearance. It is available for concealed piping (above) and for exposed piping.



New Triple Duty STRAINER-CHECK-STOPS concealed behind the HYDROGUARD cover, simplify piping and tile work. Walls are unmarred by protruding knobs or valve handles. With only one dial to turn instead of the usual 2 to 4 valves, there is no confusion on the part of the bather.



Don't skimp on Safety in Showers
Get POWERS SAFE SHOWER SYSTEMS *data*.
Call your nearest Powers office.

(c63a) ● Reg. U. S. Pat. Off.

Dynamic New Design Simplifies Shower Installation

Powers HYDROGUARD Is Thermostatic. It is the finest shower control money can buy. It always maintains the shower temperature wherever the bather sets it . . . regardless of *temperature* or *pressure changes* in water supply.

Thermostatic SAFETY LIMIT Protects Bather from Scalding. It prevents flow of water to shower above 110°F. Should cold water supply fail HYDROGUARD instantly and completely shuts off hot water.

Conserves Water formerly wasted while adjusting various valves before bathing and jumping in and out of shower because of temperature changes.

Consult Powers on Shower Planning. Call our nearest office for data on POWERS SAFE SHOWER SYSTEMS. An experienced Powers engineer will gladly help you select the best shower controls for your requirements.

For further information write for Bulletin 366

THE POWERS REGULATOR COMPANY

SKOKIE, ILLINOIS | *Offices in chief cities in U.S.A., Canada and Mexico*

65 Years of Leadership in Water Temperature Control

More PRACTICAL IDEAS

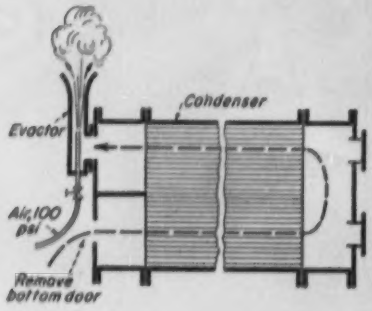
Begins on page 132

Here's how evactor and compressed air now bake out our steam condensers

We use an air evactor, sketch, to kill algae and other growth in our large surface condensers. To show you how this method compares with old way of opening waterboxes and letting condensers dry out, table, below, shows sequence of operations and time needed for both.

Here's procedure for drying with evactor: (1) Take turbine off the board, but leave it on the governor, then rack the spindle back four turns. (2) Stop circulating pump and close the 20-in. valve at outlet side of condenser. (3) Open one bottom door on the inside or platform side of condenser as soon as possible. Start compressed air through the evactor on upper door of condenser. (4) When steam stops coming out of evactor, trip the throttle and shut down. (5) Watch exhaust-end temperature; if it goes above 300 F, stop "baking" operation even if vapor has not stopped coming out of the evactor. (6) Record time of step No. 2 and step No. 4 in log book. (7) Turbine should stay down 12 to 18 hours before being started again. (8) Be sure to keep water on both h-p and i-p glands during baking out to keep them cool.

E D Driemeyer *Granite City, Ill.*



Evactor 'baking' condenser vs removing doors at one end

No. 3 Condenser 2/20/54

Time am	Min	Temp, F	Remarks
8:10		120	Saturday, 2/20/54, turbine on line with 750-kw load
8:11		130	Line breaker tripped
8:12		140	
8:14		170	Circulating pump shut off
8:18	4	170	Condenser door open—lower right-hand door
8:18	4	180	Compressed air turned on evactor, starting baking
8:19	5	200	
8:25	11	300	Indicator on 40-F reading, second time around
8:28	14	320	Indicator on 60-F reading
8:30	16	330	Indicator on 70-F reading. At this time, steam vapor ceased. Its billowing effect from lower right-hand door of evactor began pulling air through condenser
8:33	19	340	Indicator on 80-F reading. Steam vapor ceased to flow from evactor in continuous stream
8:34	20	340	Indicator on 80-F reading. Closed steam-inlet valve, stopping baking. Temperature dropped at once

TOTAL TIME FOR BAKING OUT: 8:14 to 8:34 or 20 min; maximum temp = 340 F

No. 4 Condenser 2/27/54

Time am	Min	Temp, F	Remarks
7:50			Saturday, 2/27/54, turbine on line with 2000-kw load
7:55			Line breaker tripped. 7:55 to 8:45 am, solenoid trip tested
8:45		160	Circulating pump shut off
8:48	3	140	Condenser door open—top left-hand door first
8:49	4	135	Opening doors
8:49	4	160	All doors open (4)
8:49	4	170	Starting baking
8:56	11	280	Indicator on 20-F reading, second time around
8:57	12	290	Indicator on 30-F reading
8:58	13	300	Indicator on 40-F reading
9:00	15	310	Indicator on 50-F reading. Very little steam vapor from bottom two doors
9:04	19	320	Indicator on 60-F reading
9:07	22	330	Indicator on 70-F reading
9:11	26	340	Indicator on 80-F reading. Very little steam vapor from all four doors
9:15	30	344	Indicator on 84-F reading. Closed steam-inlet valve, stopping baking. Temperature dropped at once

TOTAL TIME FOR BAKING OUT: 8:45 to 9:15 or 30 min; maximum temp = 344 F

Why don't manufacturers make better packing hook?

I used every make of packing hook on the market, but they always broke or bent just when I needed them most. If you don't believe that, try removing packing that's baked into a stuffing box until it's hard as cast iron.

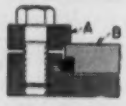
One of our men suggested that I make a packing hook from the tine of an old pitchfork used for hay. It is the best packing hook I ever had. It never breaks and is springy enough not to bend. Now I collect tines from old forks and make them into packing hooks.

A Kuchinsky *Arlington, Mass.*

Editor's note: *What other products do you maintenance men want improved? Let's hear from you.*

More info on O ring

My article on O rings for gaskets (Power, Oct 1955, p 140) needs explanation. Design was first used on 16x20 vertical, multiple-cylinder gas engines with valves set in a 2-valve cage or cylinder head. Original head was like my sketch, except parts "A" and "B" were made in one piece. Because



there's open space under flange "A", bolt pressure brought about by an engineer's muscular enthusiasm would spring and even break.

Making this flange a separate ring stopped the trouble. If a flat gasket were used instead of an O ring, it might illustrate my point better.

A Y Edwards *Toledo, Ohio*

Editor's note: *Reader Edwards' idea is a good one for his application.*

Doping gasket

Never use dope on both sides of a gasket. That often causes blowout because then gasket slips between flanges.

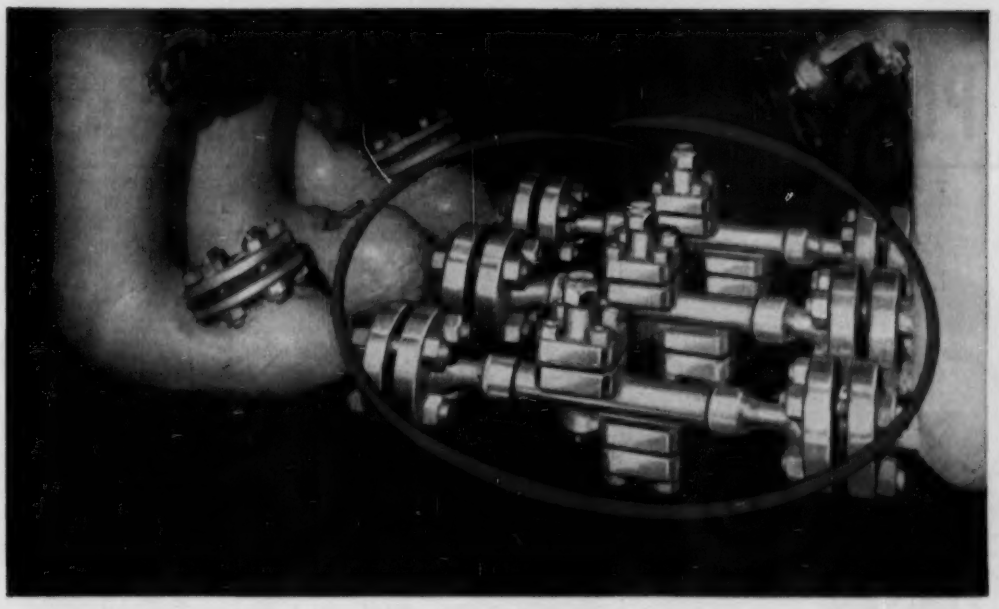
M A Stevens *Flushing, N. Y.*

Did you know . . .

that crude oil often contains large amounts of water? (What marine engineer doesn't?) This can result in flame failure if slugs reach the burner.

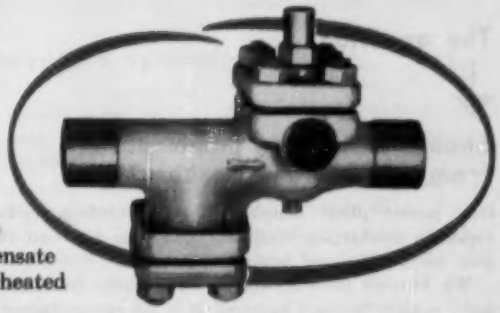
My biggest boner . . .

Please turn to page 200



Three Yarway Integral-Strainer Impulse Traps draining main steam lines in large mid-west power plant. Other Yarway traps drain extraction lines in same plant. Yarway Integral-Strainer Impulse Traps are available with welding or flanged connections. Pressures 600, 1500 and 2500 psi.

HIGH STEAM PRESSURES AND TEMPERATURES CALL FOR YARWAY INTEGRAL-STRAINER STEAM TRAPS



YARWAY Integral-Strainer Impulse Steam Traps drain some of the hottest steam lines in the country—temperatures up to 1000° F and pressures as high as 2500 psi.

When system is being warmed up these traps have ample capacity, yet will handle relatively small amounts of condensate without losing prime . . . and in the presence of dry or superheated steam, the trap valve snaps shut.

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For complete description write for Bulletin T-1740.

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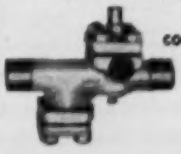

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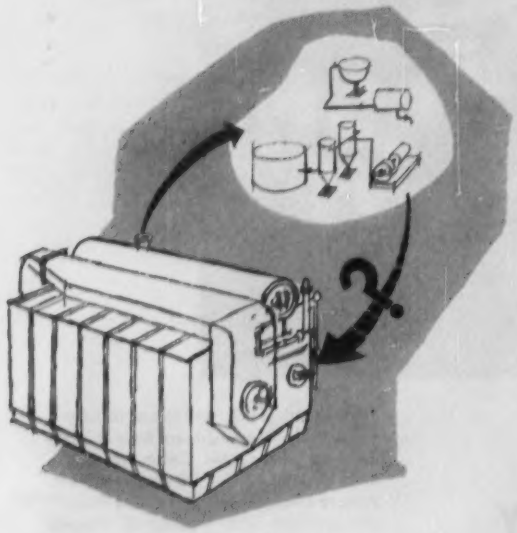
PLANT PROBLEMS... here is readers'



The question

Should we return condensate from our factory process?

Our power plant supplies about 50,000-lb-per-hr steam to production facilities. Use is at 125 and 10 psig for process and heating.

We haven't been returning condensate from factory, mainly because some of it is oil contaminated. But also because we didn't want to invest in a condensate-return system.

As water costs—for both raw water and treating—continue to climb we're taking a second look at the picture to find out if we should go ahead with a return system, oil separators, etc.

Our plant is fairly well spread out. It covers about 15 acres. But boiler plant is centrally located. At best we could probably recover 60% of the condensate. Contaminants make balance useless.

We'd like *Power* readers' opinions on whether we should go ahead with the proposal.—*PRJ, Jan Power*

The answers

Here's how *PRJ* can make a preliminary study

In coming up with an answer to *PRJ's* problem I've assumed some typical figures. In a preliminary study, he can substitute actual figures that show whether to go ahead with a detailed survey and design by an outside consultant.

Let's assume that (1) Condensate recovery on 50,000 lb per hr is 60%, yielding 30,000 lb per hr condensate returns. (2) Raw water costs $0.20 per 1000 cu ft. Water savings are $2.30 per day, or $840 per year. (3) Plant life is 15 years. (4) Borrowed money costs 5%. (5) Repairs and maintenance cost 5%. (6) Initial cost of system is $30,000 ($2000 an acre) for a gravity condensate return to one or more sump-pump pits. Equipment includes pump, motor, controls, piping, receiving tank, building. (7) Engineer's fee is 12%—$3600. (8) Pump motor is ½-hp.

Capital recovery factor for 15 years at 5% is 0.09634 (see *Principals of Engineering Economics*, by Grant). Thus, based on $30,000 plant cost plus $3600 engineering cost:

0.09634 × $33,600 = $3237.02 yearly cost of money.
5% × $30,000 = $1500 for repairs and maintenance.
$.04 per hphr × ½ hp × 8760 hr = $175 for power.
$30,000 × .30 × .03 = $270 for 3% property tax increase at 30% assessment rate. *Total yearly cost:* $5182.02

To figure heat recovery, assume condensate returns at 20 F above raw-water temperature:

30,000 lb per hr × 20 = 600,000 Btu per hr recovery.

If heat costs $.0025 per 1000 Btu:

600 × 24 × .0025 = $36 per day, or $13,140 per yr.

We've already seen that raw-water saving is $840 per year. Reasonable chemical-treating cost is $1.00 per million pounds of raw water. Chemical-treatment savings are:

1.00 × 262.8 million lb = $262.80 per year.

Net result shows a $14,242.80 yearly gross saving. Net saving (after subtracting $5182.02 yearly cost) is $9060.78.

If *PRJ's* preliminary study looks like the one above, he should call in a consultant to make a detailed survey and design the condensate-return system.

F L GILLMOR *Albany, N. Y.*

I would reject condensate that's oil contaminated

I believe a condensate-return system would be profitable for *PRJ's* plant, but would dump all contaminated condensate to the sewer. Oil separators will not do a perfect job. And the savings realized by returning condensate with oil in it are soon offset by increased maintenance costs. Separators, traps and boilers will need frequent cleaning.

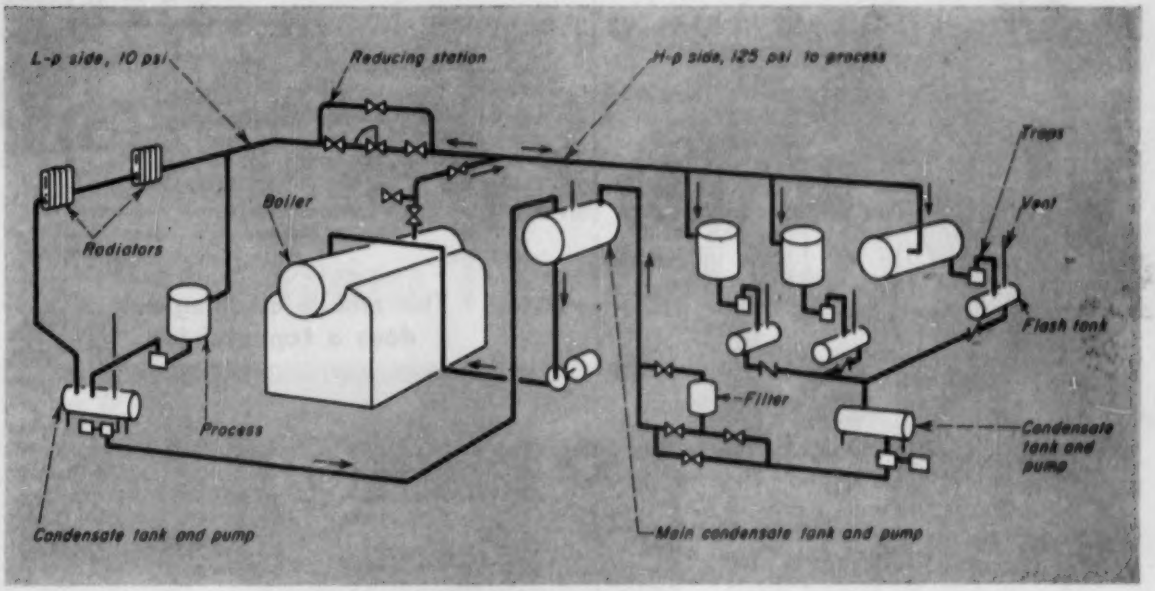
All condensate could be returned from the 10-psig heating load since it's probably free of contaminants. By recovering condensate from the l-p load only, *PRJ* will eliminate need for h-p condensate receiving and pumping units as well as an h-p return line.

In smaller plants, added maintenance can easily erase savings resulting from system changes.

R J ANDERSON *Winona, Minn.*

know-how put to work

HOWARD KALLEN, *Associate Editor*



Right hookup for condensate-return system

PRJ's high-pressure processing equipment is, no doubt, equipped with flash tanks vented to the outside. Condensate from traps to flash tanks could pass into condensate-return tanks that are automatically operated by float switches. These actuate motor-driven pumps. Condensate-pump discharge is filtered before entering main condensate tank.

The l-p steam line, supplying 10-psig steam to heating and process, returns condensate to the boiler in much the same way as the h-p side of the system.

PRJ should make an oil-test gage from one-inch gage glass, about 20 inches long. Painted white cork with a ⅛-in.-diameter black dot at one end closes off gage glass. Black dot is seen when looking through glass from open end. Filling the gage with contaminated condensate shows cloudiness. But if black dot can still be seen from open end, the oil contamination can be removed by cloth filter pots. If dot can barely be seen, anthracite filters should be used.

J M Gorrie — *Euclid, Ohio*

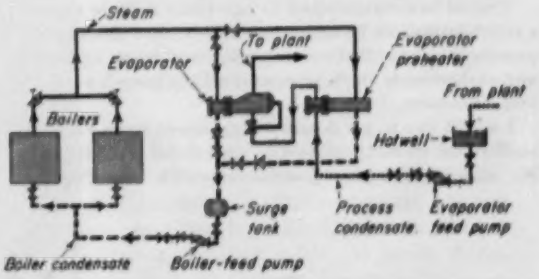
Evaporator licks condensate contamination

One solution to *PRJ's* problem is shown in the sketch at right. It employs a *heat-transformer evaporator* allowing 100% condensate recovery.

Closed heater preheats the returning condensate before it enters the evaporator. Steam generated from condensate in evaporator feeds plant processes. With this arrangement, condensate returns to boilers without being contaminated. Makeup is thus limited to normal blowdown requirements. If heater or evaporator tube leaks, the higher-pressure boiler steam flows into the process circuit, prevents lower-pressure (contaminated) process condensate from entering the boiler.

Although first cost of the heat-transfer evaporator and its required auxiliaries is greater than a simple condensate return system, resulting efficiency boost often justifies its installation. If *PRJ's* plant steam demand of 50,000 lb per hr is nearly steady for 24 hours per day through most of the year, he should give this setup careful consideration.

H B Wayne — *Brooklyn, N. Y.*



Want free consulting service? Send in your design and operating headaches to us. We'll give readers a whack at them.

Turn page for info on cleaning heat-exchanger tubes

More PLANT PROBLEMS

Begins on page 138

The question

What's a good way to clean heat-exchanger tubes?

I was recently put in charge of heat-exchanger maintenance for a medium-sized chemical plant that also generates its own electrical power. We're big users of surface-type heat exchangers.

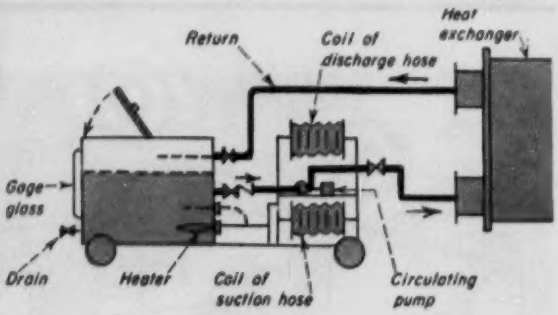
Until now, there has been little or no planning for heat-exchanger maintenance, especially tube cleaning. I'm convinced we could do a much better job by standardizing on cleaning methods, frequency and possibly, fixtures that could speed up cleaning.

Typical heat exchangers in our plant include feedwater heaters, oil heaters and coolers, and chemical-process heaters. Tube materials vary from carbon and carbon-moly steels to copper alloys, monel, nickel and aluminum.

I would like to get detailed suggestions from *Power* readers on cleaning materials, successful techniques. My aim is to set up procedures.—*MS, Jan Power*

The answers

EDITOR'S NOTE: *For more on heat-exchanger cleaning, see page* 116



This mobile cleaning unit does a topnotch job

A 50- or 100-gallon tank, with circulating pump, immersion heater and hose, all mounted on wheels, makes an ideal unit for cleaning heat exchangers—especially if you have welding-machine outlets spotted around the plant. The entire unit can be automatic.

Take heat exchanger out of service, blank inlet and outlet of side to be cleaned. Hook up hose to fittings on blanks and circulate solvent or chemical solution through heater. Trial-and-error or lab tests show best cleaning agent and approximate cleaning time.

Mobile unit should be built of stainless steel throughout, so any chemical solution can be used. Size tank and locate fittings to allow for settling of solids.

J R MUNRO — *Port Mellon, Can.*

Combine mechanical and chemical cleaning

Comparing costs of chemical and mechanical cleaning could supply an answer to this problem. But often a combination of both methods can be used. Three or four chemical cleanings could be followed by dismantling and cleaning heat exchangers mechanically. At this time the exchanger can also be given a visual inspection and hydrostatic test.

Cost is always a major factor in cleaning maintenance. By finding effect of dirty exchangers on plant efficiency, an economical time between cleanings can be figured.

H R MATHISON — *Elmont, N. Y.*

Steps MS should take to plan cleaning program

MS can find out when a heater needs cleaning by checking the terminal temperature difference with thermocouples. When TTD exceeds four or five degrees it's time to consider cleaning. Also, pressure-drop increase is an indication of iron deposits in tube.

First cleaning operation consists of pumping inhibited hydrochloric acid through shell and tubes. Periodic analyses should be made of the chemical effluent to find out its iron content. Iron content normally rises to a peak, levels off and then drops almost to zero in about four to five hours.

If time permits, exchangers should be water-rinsed. But a caustic solution should follow in any case, to neutralize

For more on heat-exchange cleaning and new problems, turn page

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More PLANT PROBLEMS

Begins on page 138

the metal surfaces. This operation takes two to three hours to insure removal of all acid.

Disposal of the used solutions after cleaning may be a problem. Local ordinances should be reviewed to find out whether the chemicals can be dumped directly into the river.

Chemicals for heater cleaning should be restricted to the shell and tubes—not be allowed to enter connecting piping. Line valves connect close to heater nozzles. And smaller-size flanged nozzles between valve and waterbox at both inlet and outlet accommodate chemical cleaner.

At a low point common to all heaters, caustic and acid mixing tanks, each connected to the same pump, serve as recirculation storage tanks. The pump discharges through piping to both inlets on the heater. And chemical discharge lines join after leaving the heater. Common header then feeds into acid and caustic tanks. Proper valves are operated to return each chemical solution to its own storage tank.

Oil heaters don't usually need chemical cleaning because they operate at relatively low temperatures. In systems using untreated water for heating and cooling oil, efficiency may drop as a result of algae growth. If valves and piping are installed so flow can be reversed to break off growths, the condition can be relieved. Injecting small quantities of chlorine in the water prevents algae growth.

Another way to clean inside of tubes (if only straight tubes comprise the tube bundle) is to remove waterbox cover as well as tail end of the shell. Then force compressed-air powered plugs with brushes through each tube. It's important to keep close tabs on brushes so none are left in the tubes. After brush cleaning, an air test can be run on each tube by adapting a pressure gage to the tube outlet and applying air to the opposite end. Pressure drop, while both ends are closed off, shows up a pinhole.

A J Breugelmans — *New York, N. Y.*

Outside cleaning firms get good results

Analysis of past experience, visual inspections and, above all, acid cleaning are the tools that will speed heat-exchanger cleaning operations for *MS*.

Cleaning records should include equipment data, such as tube numbers and sizes, before and after conditions, total man-hours per cleaning operation, total cost. From these figures he will soon be able to forecast an approximate cleaning date for each heat exchanger and schedule it accordingly. Caution: Many schedules have fallen flat because the man in charge didn't know some tubes were left plugged and some badly gouged by faulty cleaning operations.

Acid cleaning in the hands of a reliable firm that specializes in such work can be useful. Never overlook outside help when units must have fast attention to keep them on the line. Special permanent acid piping can be installed to make the job faster.

Don't forget: You can see through a clean straight tube. Thus, a visual inspection when the exchanger is off the line may reveal stoppages from sources other than scaling.

E F Wehlage — *Fairport, N. Y.*

YOUR APRIL PROBLEMS

1 What caused the shock in this chemical process?

Manufacturer of solutions for cleaning and polishing uses 115-230 volt single-phase current for lighting and 550-volt 3-phase current for power.

Chemical solutions are mixed in sheet-metal-lined wooden tanks surrounded by a wooden walkway with sheet-metal covering. Tank lining and walkway are not connected electrically or otherwise.

Foreman reports that a worker standing on the sheet-metal-covered walkway received a continuous shock when his finger was dipped into the tank solution. Shock power increased when the finger was further immersed. Tests of adjacent piping with a millivoltmeter didn't show any potential differences.

Tank solutions were agitated periodically by a motor-driven propeller carried over the tanks by a monorail. But motor tests didn't reveal a ground.

Condition was licked by electrically connecting the tank lining and walkway covering at four points. In addition, two connections were carried to the main water-supply pipe. Was the trouble caused by static? Would the problem have existed if a grounded neutral had been used on the 550-v distribution? What tests can be run to get at the basic cause?—*CVD*

2 How can I modernize our building heating system?

I'm plant engineer for an electrical-equipment manufacturing company that's experienced a rapid growth during the last five years. We plan to pick up needed production space by adding a one-floor building about 150 ft square, next to our old building, which is a 3-story structure about 200 ft square.

Steam-heating system, put in about 30 years ago, needs modernizing badly. Two old low-pressure heating boilers have underfeed stokers. Ash removal is manual. Steam-distribution system, drainage, venting and control are inadequate by today's standards.

We'd like to take advantage of summer shutdown to do a complete system revamping. And, at the same time, we'll provide heating for the new building too. We plan to add a new boiler, condensate-return pump, etc. We're also considering oil firing. Have *Power* readers system design tips or experiences of their own to offer?—*SJT*

Sit down right now and answer one or both of these problems. We'll pay extra for answers with photos or sketches.

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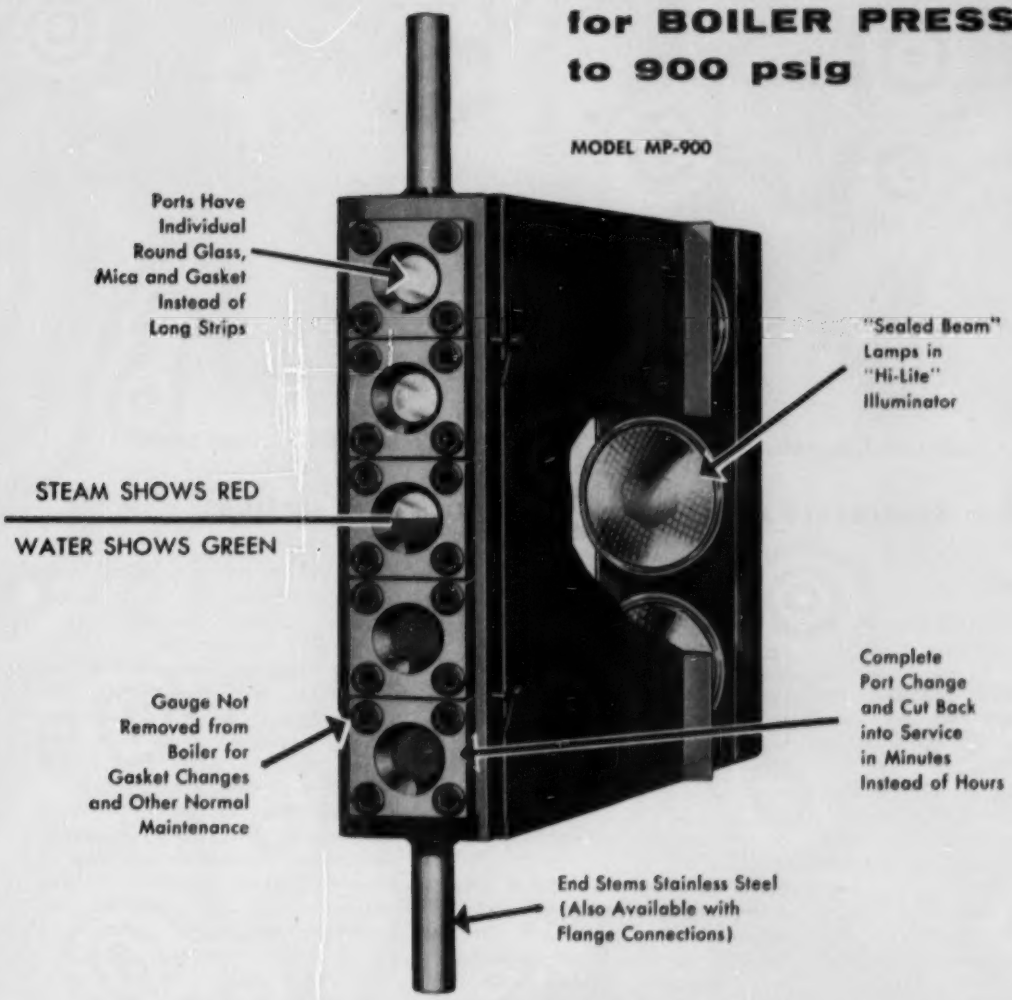
for BOILER PRESSURES to 900 psig

MODEL MP-900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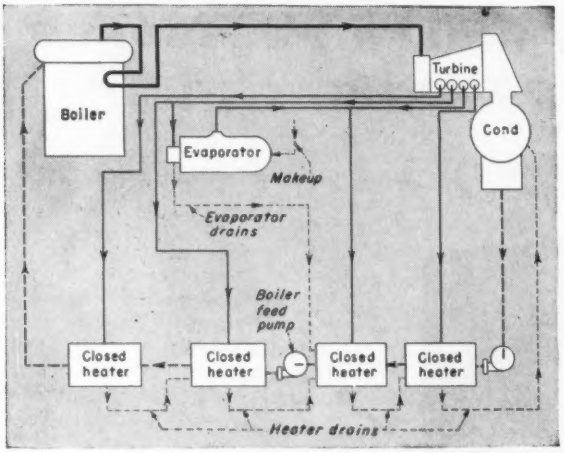
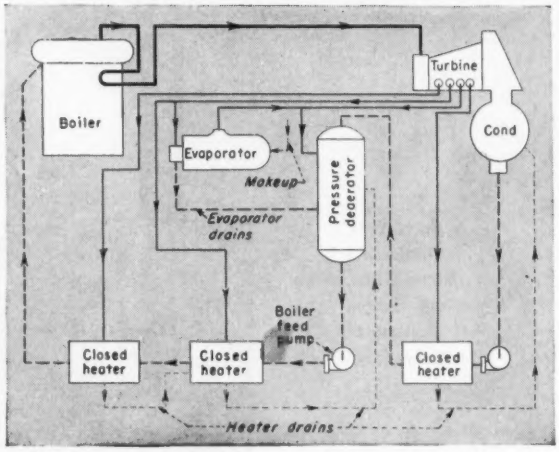
ARGUMENTS . . . *it pays to pop your safeties here*

ALTHEA THORNTON, *Assistant Editor*



WITHOUT DEAERATOR (closed feed cycle)



WITH DEAERATOR (open feed cycle)

Are deaerators necessary in today's central stations?

The argument:

Today's deaerator was known as an open heater when feedwater was heated by exhaust steam. As such it was indispensable to power-plant operation. It also removed air from raw water since cold makeup was introduced at that point.

But is a deaerator necessary in modern central stations where all makeup is evaporator-distilled water and stage heating is used? Plainly, there is no air in the system.

True, the small amount of makeup from distilled-water storage may contain some air. But this air is liberated in the condenser where the makeup enters. Even assuming some air gets into the feed system, the high cost of deaerator equipment is still not justified because air traces can be removed chemically. But I don't admit there is air in feedwater when makeup or evaporator distilled water is fed into the hotwell.

I think eliminating the deaerator would greatly simplify power-plant design and operation.

N T PEF *Wallaston, Mass.*

Readers' answers:

In central stations, engineers can be divided into two schools. Those: (1) advocating no separate deaerating heater, with deaeration done in the turbine condenser (2) recommending use of deaerating heaters at all times to remove oxygen to not more than 0.005 milliliter per liter ahead of the high-pressure heaters and boiler. This avoids trouble with magnetic iron-oxide deposits. It also acts as a large feedwater storage above the high-pressure boiler feed pump, which is always needed in the cycle. Most central stations use deaerating heaters.

V J CALISE
Graver Water Conditioning Co

Many apparent advantages of hotwell deaeration are enumerated in Pef's letter, but he oversimplifies the problem by implying that you can omit the boiler feed pump. It's not practical to depend on the hotwell pump for feeding water directly to modern high-pressure boilers.

Also, Pef has not mentioned any limitations of hotwell deaeration, as for example: (1) When deaerating under vacuum there is always danger of oxygen infiltration through pump glands and pipe connections. (2) The hotwell deaerator is generally less efficient at light loads, and is also influenced by the ratio of cooling-water temperature to vacuum. Even under the most favorable operation, the hotwell deaerator is not guaranteed to reduce oxygen as low as a deaerating heater does.

The deaerating heater's efficiency is guaranteed at all flow rates from zero to rated capacity. And it deaerates all water held in storage regardless of

(*Continued on page* 204)

Reader Pef's argument is quite logical, but by no means new. It is revived each time engineers start laying out a new steam-generating station.

Some engineers recommend deaeration in the main condenser, or the "closed feed cycle." Others advocate a separate deaerator or the "open feed cycle." Sketches above show typical cycles of each type.

Proponents of the closed cycle argue that you get just as good deaeration from the modern surface condenser as from the pressure deaerator. So why increase overall plant cost by installing a pressure deaerator with its attendant cost of elevated supports to afford the required npsh of the boiler feed pumps? Why add another piece of equipment?

Those favoring the open cycle say this about the pressure deaerator:

1. It is always under pressure and any leaky valves or connections can be detected immediately.

2. It serves as a stage in the heating cycle, replacing a closed heater. If this heater is placed on the discharge side of the boiler feed pumps, it must be designed for full boiler-feed pressure. This makes it expensive. Further, the deaerator affords zero terminal differences. Usually this efficiency cannot be obtained from a closed heater.

3. Pressure deaerator provides adequate storage of hot deaerated water. In the closed feed cycle this must be provided in the main condenser hotwell, or in a separate storage tank.

(*Continued on page* 206)

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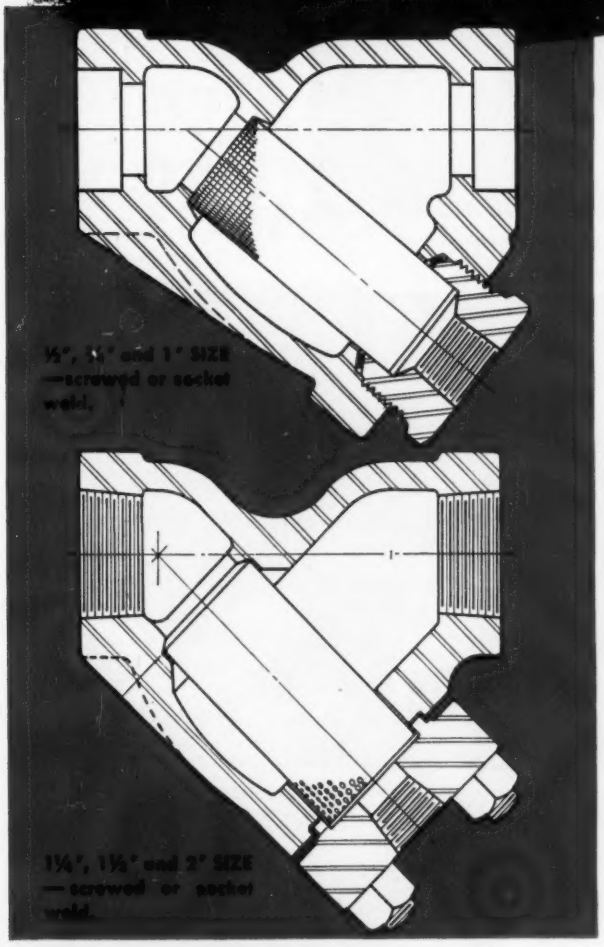

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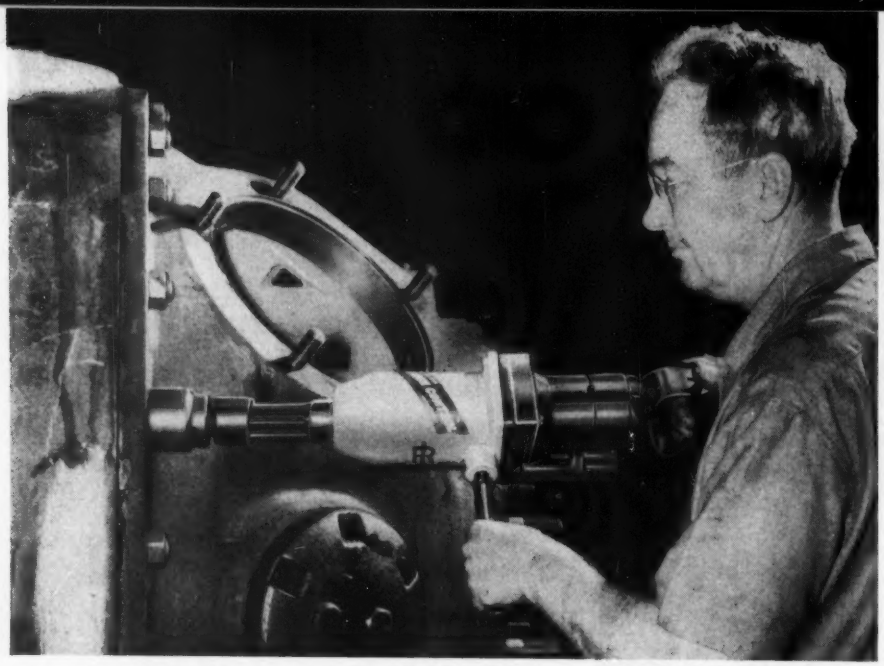
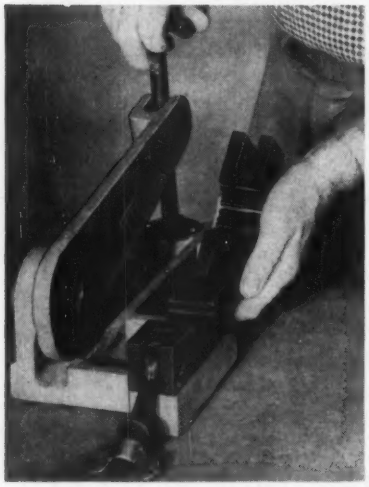
Complete price and dimensional data on Armstrong cast moly steel strainers for 900 psi, 875° service and cast semi-steel strainers for pressures to 250 lbs. Free on request—no obligation. Ask for your copy today.

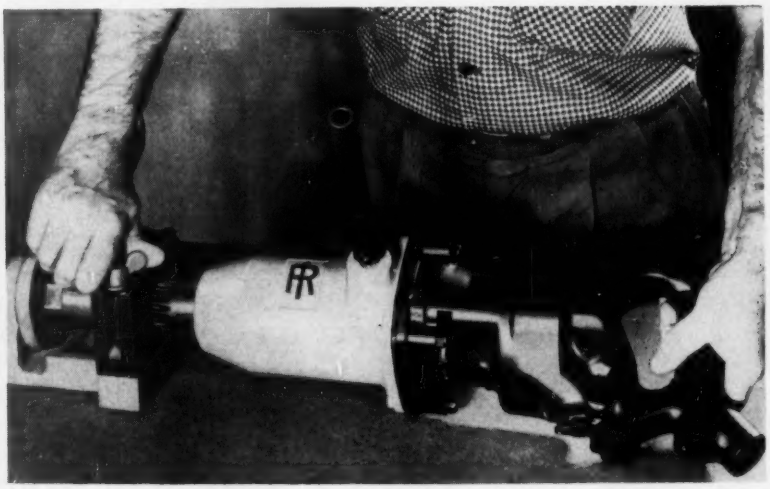
ARMSTRONG STEAM TRAPS



OVERHAULING plant equipment is duck soup for this new torque-control tool



1 Torque-setting jig has clamp that is ready to receive the new impact tool



2 Place square driver of impact tool in torque jig arm. Then clamp the anvil, as shown in this photo, to hold impact tool during change for the torque setting

HOW TO control torque with this new impact tool

► Now, this new impact tool drives nuts, cap screws and other type fasteners at full power and speed, with no pressure regulator. It also gives constantly accurate torque control. Tool is shipped with torque preset at 320 ftlb. Torque can be quickly and easily set, using the jig shown. Action of torque-control mechanism is like a pogo stick, bounding evenly while on soft ground, suddenly bounding higher when it strikes a hard surface. While nut is being run to required torque, tool operates at normal power and speed. But when set torque is reached, and nut running resistance is equal to stress preset in torsion bar, impact mechanism rebounds and instantly tips a foolproof rubber-faced shutoff valve. Releasing the trigger resets the tool for next nut running operation for you. —*Courtesy, Ingersoll-Rand, Phillipsburg, N. J.*

3 Turn the adjusting screw like this to change torque setting on torsion bar

You get MORE CAPACITY with a FANMIX BURNER

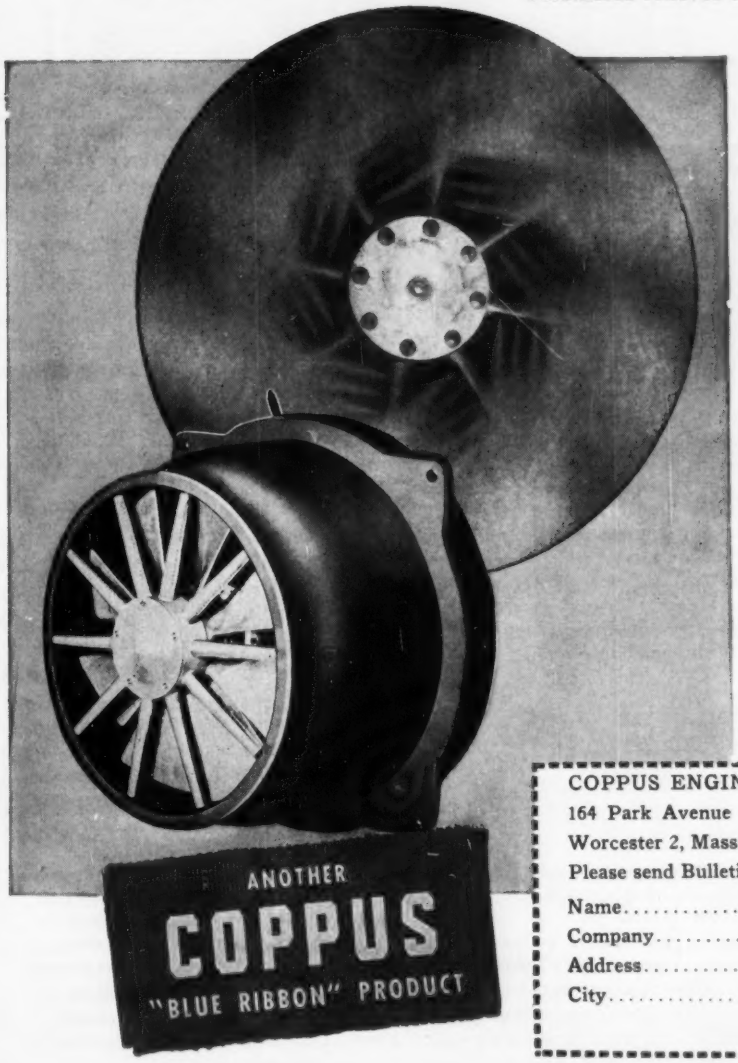
Increase Boiler Ratings On Present Or Planned Equipment

In all types of Coppus-Dennis FANMIX Burners — straight gas or combination gas-oil — we utilize the energy of the fuel under pressure to drive the burner fan and deliver air in the proper proportion to the fuel flow. This exclusive "pinwheel action" *mechanically* mixes fuel and air in exactly the right proportions for truly radiant, non-luminous heat.

The result is uniform temperature everywhere in the combustion chamber — no drifting "hot spots" — and complete combustion under all conditions. That's why you can release more heat into your present furnace — why in new installations you get more heat into smaller furnace space.

FANMIX Saves On Both Old and New Installations

FANMIX can easily be operated with your present furnace and stack, requiring only minor changes in other equipment. Or if you're planning on new boilers, remember that FANMIX relieves the furnace from the burden of mixing, creates its own forced draft and takes smaller pipe sizes. Which means you can plan on reduced combustion space, less stack, no forced draft equipment and lower installation costs all around.



Get the Whole Story

Coppus engineers FANMIX Burners to meet individual requirements, providing complete control over heat pattern and combustion . . . Learn more about how "pinwheel action" can step up *your* boiler performance to peak efficiency and economy — as it is doing throughout industry. Send for Bulletin 410-6. Coppus Engineering Corp., Worcester 2, Mass. Sales Offices in THOMAS' REGISTER. Other Coppus "Blue Ribbon" Products in BEST'S SAFETY DIRECTORY, CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG, and MINING CATALOGS.

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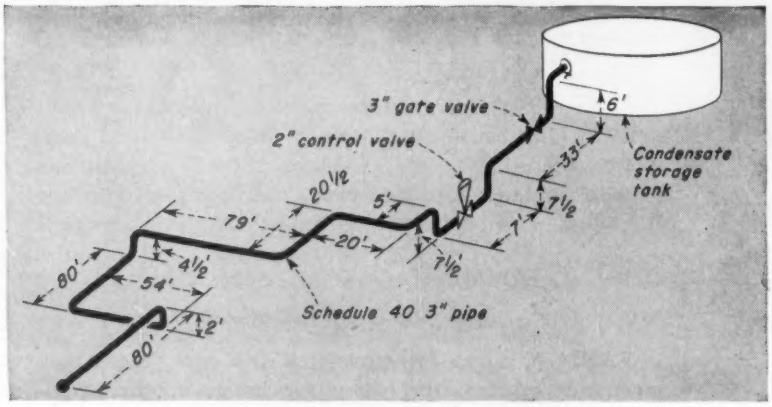
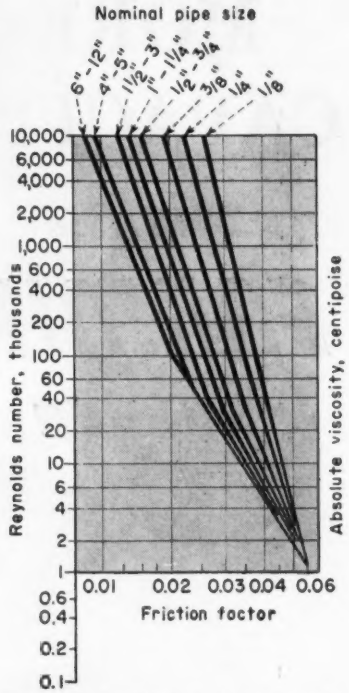
BASICS . . . *bringing engineering theory down to earth*

HOWARD KALLEN, *Associate Editor*



PIPING SYSTEM LAYOUT is a helpful guide in figuring friction pressure drop



FRICTION FACTOR is picked off the graph, after figuring Reynolds number

FLUID FACTS—8

Pressure drop in liquid lines

► LAST MONTH we outlined steps in solving pressure-drop problems using the Fanning formula. Now let's solve a problem that puts this info to work.

Drawing, top at right, shows a low-pressure condensate-return line. From heat-balance data we know flow is 30,000 lb per hr. Average condensate temperature is 212 F. Before finding friction pressure drop it's smart to convert flow to gpm. At 212 F, water density is 8.00 lb per gal. Flow rate is:

30,000 lb per hr/ 60 × 8.00 = 62.5 gpm

Available handbook reference data list friction pressure drop in liquid lines for various flow conditions. But you may be dealing with flow conditions that aren't tabulated. When this happens you'll have to work out the problem from scratch.

Following the outline set down in last month's Basics, first find viscosity from a graph of temperature vs viscosity for the liquid. Viscosity of water at 212 F is 0.28 centipoise.

Next step: figure Reynolds number:

$R = 50.7\ Q\ r/du$

where

R = Reynolds number

Q = flow rate, gpm

r = water density, lb per cu ft

d = inside diameter of pipe, in.

u = absolute viscosity, centipoise

For 3-in. Schedule-40 steel pipe at specified flow, Reynolds number is:

$R = 50.7 \times 62.5 \times 59.81/3.07 \times 0.28$

$R = 220{,}600$

Reynolds number shows flow is well within the turbulent range. And graph of Reynolds number vs friction factor, above, for 3-in. steel pipe yields .022 friction factor. We're now set to find friction pressure drop. Using another form of the Fanning formula:

$\Delta p = .0215\ frQ^2/d^5$

where

Δp = press. drop, psi per 100 ft of pipe

f = friction factor

$\Delta p = .0215 \times .022 \times 59.8 \times 62.5^2/3.07^5$

$\Delta p = .41$ psi per 100 ft

This figure can be applied to the total straight-pipe length of 406 ft:

$.41 \times 4.06 = 1.67$ psi

Thus far we haven't accounted for friction pressure drop in fittings and valves. Charts in engineering handbooks give friction drops for these items in terms of a straight-pipe length that would cause the same pressure drop. A 3-in. medium-sweep elbow, for instance, has the same pressure drop as seven feet of straight 3-in. pipe. Thus, seven feet is the *equivalent length* of a 3-in. medium-sweep elbow. Tabulation of equivalent lengths for the system we're studying looks like this:

14 elbows at 7 ft ea.	=	98 ft
1 gate valve at 2 ft	=	2 ft
2 reducers, 3x2 in. at 2 ft ea	=	4 ft
Total equivalent length	=	104 ft

$.41 \times 1.04 = .43$ psi

Pressure drop due to the control valve can be found from manufacturer's alignment charts or tables. For the 2-in. control valve of our system it might well be about 4 psi. Thus, total system pressure drop due to friction is:

$1.67 + .43 + 4 = 6.1$ psi

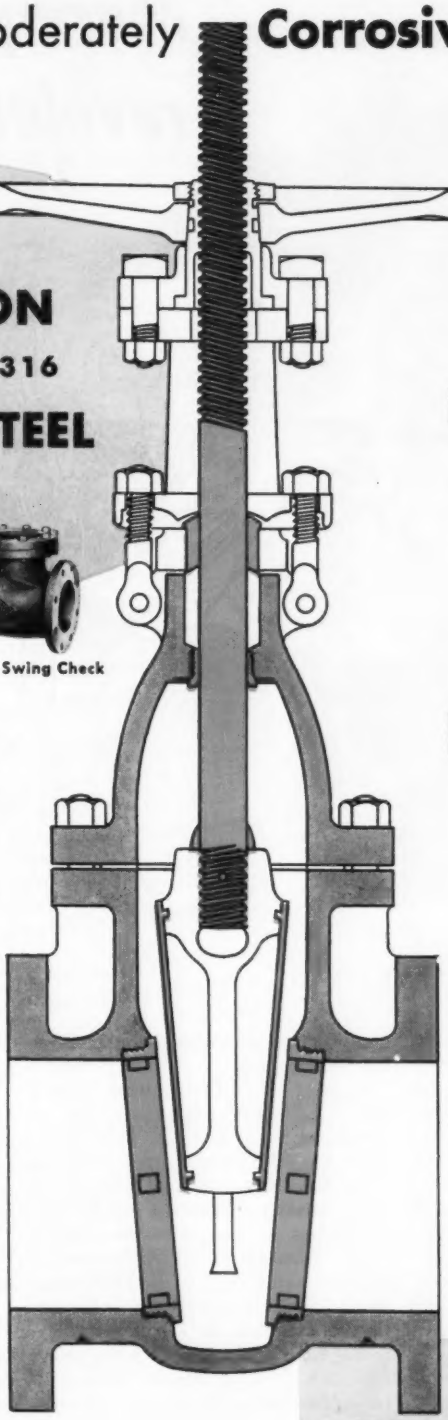
Relatively low friction pressure drop for this line may show that a smaller pipe size can be used. But before deciding to trim line size, we'd refigure pressure drop, check on available pumping power, investigate effect on the control valve, find out cost of added power needed to overcome increased friction pressure drop.

for lower cost control of moderately **Corrosive** fluids

Fig. 2651-A Gate

JENKINS NICKEL IRON Valves with Type 316 STAINLESS STEEL Trim

Fig. 2624 Swing Check



Every part in contact with fluid is the right metal to block corrosion and beat wear.

Cast NICKEL IRON

- **BODIES** Heavy duty, dimensioned for greater resistance to wear and abuse. Through port design in Gate Valves.
- **BONNET** Rugged construction, like body. Swing-type gland bolts. Screwed-in back-seating bushing. Deep stuffing box.
- **YOKE** Integral with bonnet in 2" to 4" sizes.
- **WEDGE** In 10" to 24" sizes, with Stainless Steel Wedge Rings.
- **COVER** In Check Valve.

Type 316 STAINLESS STEEL

- SPINDLE
- GLAND
- BONNET BUSHING
- SPINDLE WING
- WEDGE of I-beam structure in 2" to 8" sizes.
- WEDGE PIN
- WEDGE RINGS Rolled into Nickel Iron Wedge in 10" to 24" sizes.
- SEAT RINGS
- DISC and HANGER in Check Valve

PRESSURE RATINGS

2" to 12"—200 lbs. O.W.G.
14" to 24"—150 lbs. O.W.G.

This combination provides corrosion resistance well above the moderate need in many processing services with an investment well below that for all-stainless steel valves.

Designed primarily for the chemical process industries, they are recommended for control of mildly corrosive liquids with minimum quantities of mineral acids, such as creosote in wood treatment, and many liquids carried in petroleum processing.

A major use is in pulp and paper processing, particularly in lines serving the digester, and in the chemical recovery cycle. Service records in lines carrying the valve-punishing "black liquor" give Jenkins Nickel Iron Valves top performance rating.

Jenkins *extra value* construction throughout. Get details — compare. See why they stretch your valve investment dollar — with longer service life, lower maintenance cost.

ALSO RECOMMENDED for fluids used in electroplating, photograph finishing, textile bleaching, dyeing and finishing and heat treating of metals.

GET COMPLETE SPECIFICATIONS from your Jenkins Valve Distributor, or write: Jenkins Bros., 100 Park Ave., New York 17. Ask for Bulletin 118.

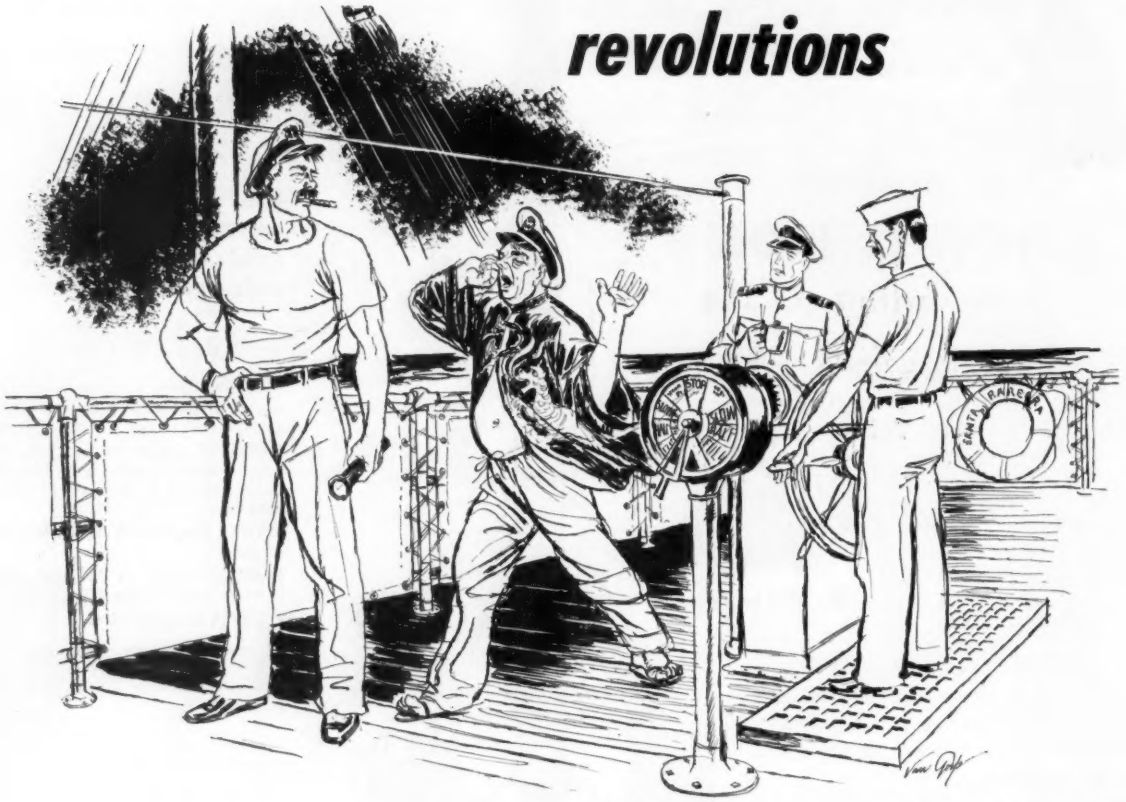
JENKINS VALVES

LOOK FOR THE JENKINS DIAMOND

SINCE 1864 TRADE JENKINS MARK

Jenkins Bros

Marmy's lost revolutions



"What the rattling hawsepipe are those fiddley engineers up to now?" raved the skipper before he saw Marmaduke

► WATCHING THE GIANT SS *United States* back out of her Hudson River dock a few blocks away under my 26th-floor window brought on that wanderlust for the sea. For a few minutes, I was in skivvies and khakis again, down below in the engine room of a deep-sea rust bucket. Then I daydreamed into the Mediterranean, through the Suez Canal and on into the Indian Ocean. Stopping at Singapore for a day, I headed for the South Sea Islands.

That did it. I put on my hat and coat and made tracks for that old two-fisted, hard-drinking marine engineer, Marmaduke Surfaceblow. Before long, I was climbing the rickety steps to his dingy office above O'Houlihan's Machine Shop & Engine Works.

A blast of tobacco smoke greeted me as I pushed the door open. Wiping the tears from my eyes, I blinked a few times and peered into the No. 6 Ringelmann smoke screen. Gradually, through smarting eyes, I could make out Marmy, sitting on his swivel chair, with his size-16 canal boats resting on his tired old roll-top desk.

Stepping inside, I heard what sounded like a half-dozen salty characters, all talking at the same time. Their voices came from the leather settee along the wall. During a second of silence, one voice croaked, "Take the old SS *City of Delhart* of the American Pioneer Lines. When her thrust bearing burned out one stormy night in the Yellow Sea, we . . ." But that's as far as he got.

"Bilgewater on fouled-up machinery in the Yellow Sea, the Black Sea or the Red Sea," roared Marmy with such force that the smog cleared instantly, being pulled out through the open window by the evactor action caused by that blast. "I'll tell you landlocked engineers about two 4000-hp diesel engines that slowed down suddenly when there wasn't anything haywire down below."

That explosion not only cleared the air, but silenced everyone. I sat down in a corner and listened. Marmy reached over to the pot-bellied stove, poured himself a cup of drain cleaner from the steaming coffeepot without leaving his seat. After ballasting his settling tanks, he lit off a new piece of rope yarn and blasted away.

"Back in 1930, I was chief engineer of the motor vessel *Santa Barbara*," roared Marmy in his foghorn voice. "We carried general cargo and passengers down the east coast of South America, brought back fruit from Chile, copper, nitrate and guano from Peru, coffee from Colombia and bananas from Panama.

"The *Santa Barbara* was only two years old at that time. She had two 4000-hp air-injection 2-cycle crosshead-type diesels that drove her twin propellers. Four smaller 500-hp diesels generated electricity. All engines were cooled with sea water.

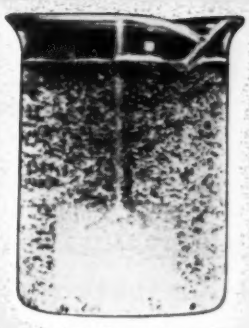
"Main engines gave trouble because 105 rpm was their top speed and we usually ran them that fast to hold the

(*Continued on page* 192)

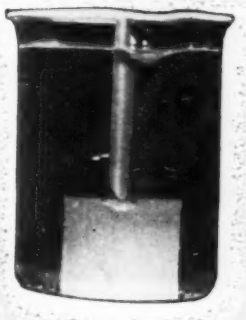
A New, Better Coagulant

NALCO 600

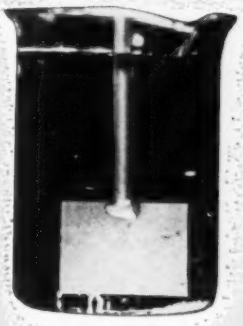
POLYELECTROLYTE



Alum



Alum plus
typical polyelectrolyte



Alum plus
Nalco 600

● As a coagulant in water clarification, and under many process coagulation conditions, new and different Nalco 600 has shown such great promise, both in performance and economy characteristics, that it has now been made available for general use as an established member of the Nalco family of chemical aids to industry.

Extremely difficult coagulation conditions provide especially economical applications for Nalco 600. It can be used alone or in conjunction with other coagulants. A very low dosage of Nalco 600 usually permits as much as 50% reduction in dosage of alum, activated silica, iron sulfate or clay type treatments . . . and results in a cleaner, clearer supernatant liquid.

Nalco 600 was invented in the Nalco Laboratories, and is being manufactured *only* by Nalco. For complete data on Nalco 600, and expert technical assistance to solve your clarification and coagulation problems, call Nalco now.

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ANOTHER *Nalco*® **PRODUCT. Serving Industry through Practical Applied Science**

NEW! "BUFFALO" a new high

MOST STREAMLINED INLET — note smooth inlet bell matching the deep drawn wheel flange to form a "true half circle" inlet into wheel.

DEEPER BLADES FOR DEEPER "BITE" — note exceptionally deep blade design in photo below. This improves air flow thru blade channels. Flanged hubs—smoothly curved for best air entry conditions.

The wheel has been dynamically tested in the "Buffalo" Vacuum Pit — possible only at "Buffalo". By spinning various rotor designs to destruction the optimum wheel construction was determined — another "Buffalo" "Q" factor.*

"Buffalo" Air Foil Wheel. Note "deep-bite" blades for most efficient air handling.

***The "Q" Factor — the*

BUFFALO

BUFFALO,

Canadian Blower &

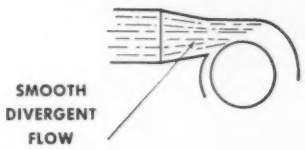
VENTILATING AIR CLEANING AIR TEMPERING PRESSURE BLOWING

"Deep Blade" AIR FOIL FANS

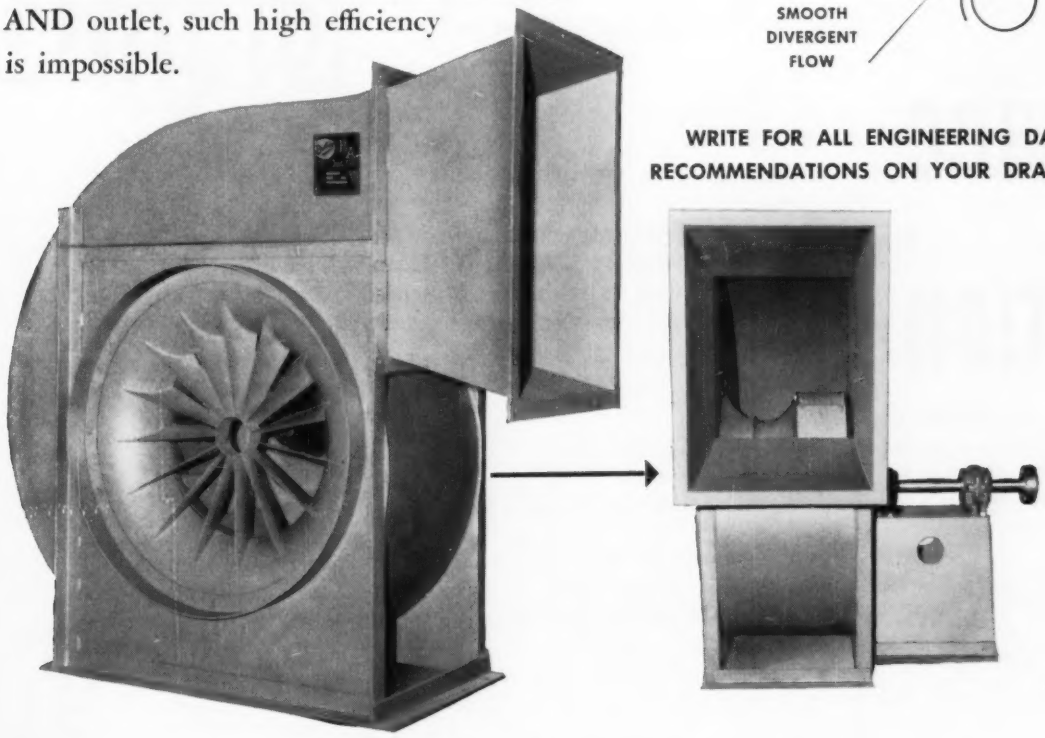
in forced draft performance

IMPROVED FAN OUTLET — reduces outlet air turbulence from fan cutoff into duct by making more even, gradual change from velocity to static pressure. Without this complete streamlining of inlet, housing AND outlet, such high efficiency is impossible.

92% MECHANICAL EFFICIENCY — not an inflated claim, but proved performance you can expect in field operation.



WRITE FOR ALL ENGINEERING DATA AND RECOMMENDATIONS ON YOUR DRAFT PROBLEM



built-in Quality which provides trouble-free satisfaction and long life.

FORGE COMPANY

"Buffalo"

NEW YORK

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INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING

Reader service section

Start with these quick samples . . .

Boon to reactor development . . .

is Battelle Institute's new critical-assembly lab. First private installation of its kind, it will be used by industry and government for direct research on atomic power plants.

Reports From the Field, p 156

High-voltage for buildings . . .

New York's Coliseum, newest show place in the world's second largest city, features the latest in electric distribution–265/460 v, sometimes called 480Y/277 v. Hard-hitting digest highlights the details of an up-to-the-minute technical paper. Other abstracts on turbines, steam plants, piping, hydro in . . .

Technical Briefs, p 158

Cracking the 4-minute mile . . .

calls for top performance, controlled speed. Performance and speed are also the key words for the first complete line of dc motors and generators built to latest NEMA standards. Data on these units, full pages on pumps, mechanical transmission, plus a hoist of other problem-solving developments in . . .

Plant Equipment News, p 162

What's new in industry?

A good way to keep abreast of the fast-moving power field is to scan the manufacturer's bulletins in this month's listing. Use the convenient post cards to order those you want.

Free Literature, p 171

Lest we forget . . .

George Edwards ''takes five'' from his busy schedule to share an Easter message from a reader. ''Take five'' to read it now–you'll find it time well spent.

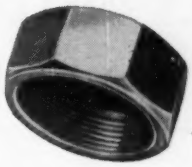
George Edwards, p 174

For other timely ideas, see following service pages ▶

Now — A Revolutionary NEW Steam Trap!

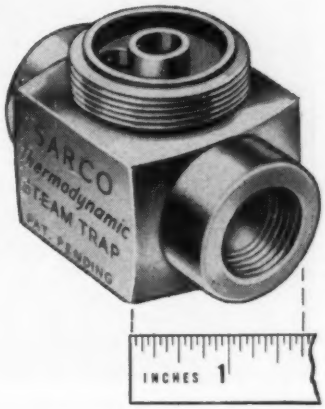
What could be simpler?

1. A CAP



2. A DISC

3. A BODY



That's all!

Practically Eliminates Maintenance!

Look at this revolutionary new thermodynamic steam trap. Could it possibly be simpler? Look for the valve closing mechanism—there isn't any! The kinetic energy of steam closes the valve and *only* the TD uses this new operating principle.

Only 3 parts ... cap, disc and body ... machined from stainless steel bar stock ... all extremely simple, rugged, durable. Only one moving part ... a hardened SOLID stainless steel disc ... practically wear-proof.

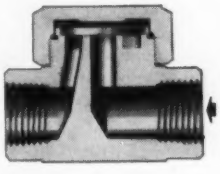
Just imagine how much time and expense this new TD steam trap can save you by greatly reducing and simplifying trap maintenance and inventory!

SOME OF MANY OTHER ADVANTAGES:

1. Use the same trap for 10-600 psi ... for light or heavy loads ... without seat or valve change or other adjustments.
2. Closes tight on no load — no steam waste.
3. Operates against back pressures up to 50% of inlet pressure.
4. Not affected by superheat, water-hammer, corrosive condensate.
5. Only one spare part—solid stainless steel disc.

TROUBLE-FREE DESIGN

No valve-closing mechanism to wear or stick—the kinetic energy of steam closes the valve. No critical clearances to choke. No gaskets to leak. Only one moving part—a SOLID stainless steel disc.



Ask for a 60 day trial installation of Sarco TD trap and strainer ... write for bulletin 257. Sarco Co., Inc., Empire State Bldg., New York 1, N. Y.

SARCO

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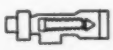
Only Sarco Makes All 5 Types

That's why Sarco can give impartial advice on proper steam trap selection.

Thermodynamic Steam Traps

Thermostatic Steam Traps

Float Thermostatic Steam Traps


Liquid Expansion Steam Traps

Camlift Bucket Steam Traps

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 244

CONTROL PANEL of reactor development laboratory contains all controls used for a full-scale reactor. Closed-circuit TV is shown on left side of the control panel

First private critical assembly lab completed

► A REACTOR development (critical assembly) laboratory — second major unit in Battelle Institute's new Atomic Energy Center at Columbus, Ohio—has been completed. It will be used by industry and government to study reactor design and construction problems relating to electrical power plants and for research on atomic engines for aircraft, ships and other means of transport. The unit is the first private installation of its kind available for direct research on atomic power plants.

According to Dr H R Nelson, in charge of the Battelle Atomic Research Center, all designs of nuclear reactors must be evaluated in full-scale-model form to provide the information needed to build operating reactors. Many decisions can be made based on theory and mathematical computations — but numerous other design factors can only be determined by experimentation. Battelle's reactor development laboratory will be available to private firms for such experimentation. It will give research technologists a tool for making studies of reactor geometry—needed before final specifications can be established for any individual reactor. It will also be used to work out practical start-up schedules, or in the case of an operating reactor, to evaluate innovations without interrupting the power plant.

The laboratory building contains about 10,000 sq ft of floor space. A room 40-ft square by 50-ft high will house the mocked-up nuclear reactor cores. Adjacent to this room is a vault for storing fissionable material. Shielded from these areas are a control room, instrument repair and machine shops, a radiation counting room and various offices.

The control apparatus was designed and built by Battelle engineers. The panel provides all the controls that would be found in a power reactor station and is also equipped with a number of research circuits. Closed-circuit television has been installed, allowing researchers to view the reactor cores while experiments are being performed.

The reactor room provides enough space for mocking-up both solid-fuel and liquid-fuel reactor cores. Ample clearance is provided so that solid-fuel cores can be built with either vertical or horizontal control and regulating rods.

Operation of reactor cores at "zero power" (about one or two watts) will yield data on fuel requirements, neutron flux, power distribution and control requirements. At zero power no shielding is required—nor is it necessary to put the reactor core in a pressure vessel or to pump coolant through the core. Thus, arrangement of fuel, moderator, control rods and other variables is flexible—can be changed readily for experimental determination of their optimum arrangement. Nevertheless, experimental cores mocked-up in the laboratory will contain all the types of atoms and a full complement of the materials needed for reactor cores capable of being operated at power levels on the order of 200,000 kw.

First unit in Battelle's Atomic Research Center, a hot-cell laboratory, was completed and put into operation in September, 1955. It is now being used in studies on the effects of radiation on reactor construction materials and other studies requiring handling of highly radioactive substances. Third unit, a swimming-pool-type research reactor, is in an advanced stage of construction and will be in operation later this year.

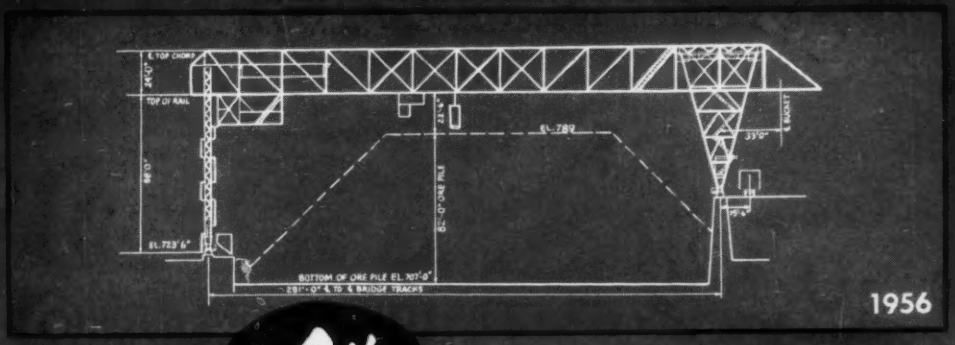
New trade association formed by manufacturers of air devices

► A NEW TRADE ASSOCIATION, the Air Moving and Conditioning Association, Inc was formed in January by 46 manufacturers of air moving and conditioning devices. Purpose of the Association is to promote and further the interests of the manufacturer of air moving and conditioning devices and the interests of the public in manufacturing, engineering, safety, transportation and other industrial problems. It also proposes to encourage development of the

(*Continued on page* 242)

UP GOES PRODUCTION AT WEIRTON STEEL COMPANY . . .

Division of National Steel Corporation



and UP goes the 4th Heyl & Patterson Ore Bridge

3rd 1952

2nd 1942

1st 1926

Any equipment that contributes to increased production by National Steel's Weirton Steel Company division must be time-tested for dependable performance.

In 1926 (30 years ago) Heyl & Patterson built Ore Bridge No. 1 . . . in 1942 Ore Bridge No. 2 . . . in 1952 Ore Bridge No. 3. All three Ore Bridges are in successful operation. Now . . . Ore Bridge No. 4 is being built by Heyl & Patterson to accelerate the ever-mounting steel production records of Weirton Steel Company.

Since 1887 Heyl & Patterson has established a reputation for designing and building Heavy Materials Handling Equipment for long-lasting service. Included in this category are: Boat Loaders and Unloaders, Car Dumpers, Conveying Systems, Cranes, Barge and Car Hauls.

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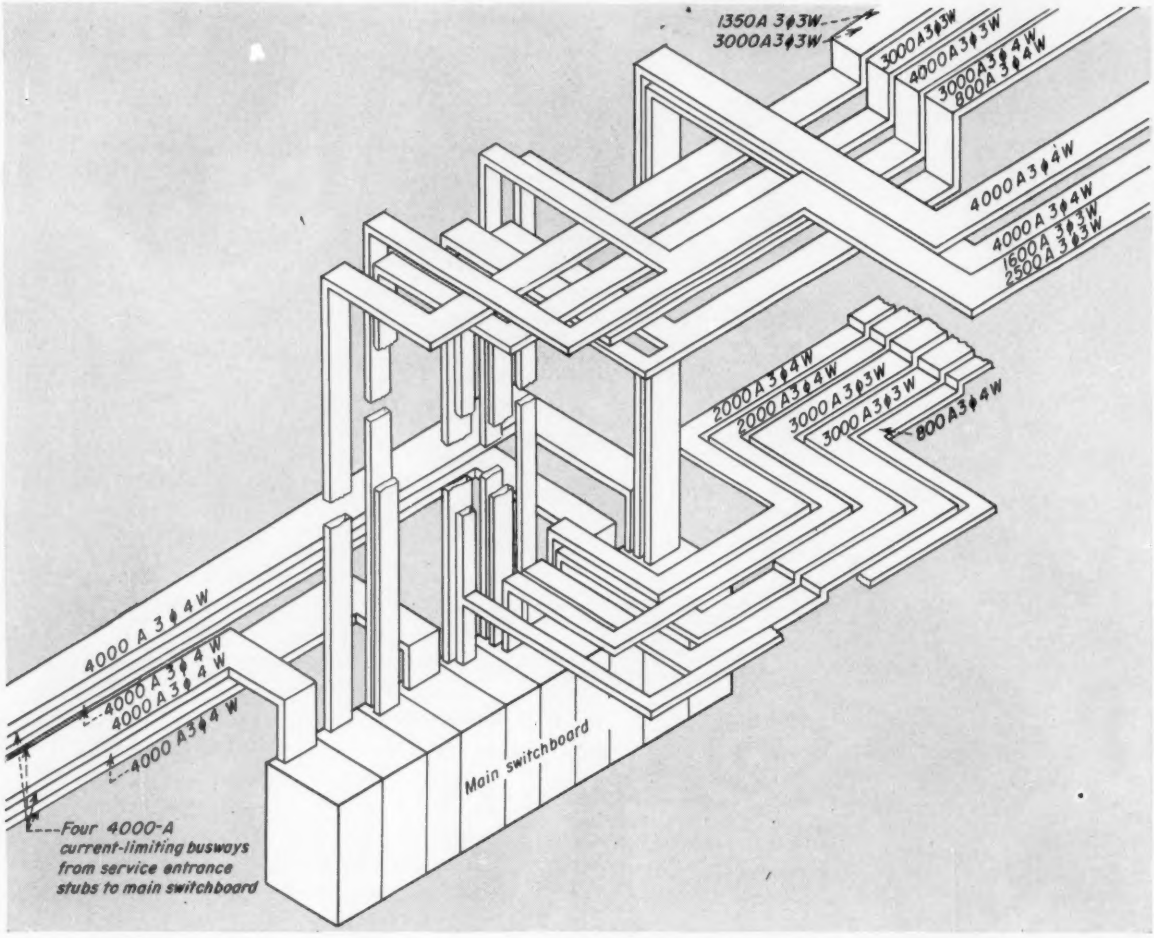


ISOMETRIC VIEW of current-limiting busways entering the main switchboard and feeder busways leaving it

New York's Coliseum features 265/460-v electric distribution

Electric power distribution in New York's mammoth Coliseum building. *By L E Fisher and H D Kurt, General Electric Company.*

The electric distribution system in New York's Coliseum, above, is one of the largest of the new 265/460 v (sometimes called 480Y/277 v) distribution systems in a commercial building.

The Coliseum is located where only secondary network service is available. Because of the extremely long feeder runs necessary in a building of this size, it became apparent early in the design work that use of the usual 120/208-v network system for this building would be extremely costly. Recent technical papers cite advantages of the 265/460-v system. Specifically, to double the voltage permits a feeder of any given ampere rating to transmit twice the power and, equally important, it can transmit twice the power for twice the distance at the same percent voltage drop.

The local utility, Consolidated Edison Co, decided to make available a 265/460-v spot network system to supply this building, resulting in savings of over $1.5 million in electrical equipment alone. This saving was not only available in first cost, but any future additions to the system will result in similar savings. For further details, see POWER, Mar '56, p 80. *AIEE paper No. CP 56-369.*

More Technical Briefs, turn page ▶

47 miles of Johns-Manville 85% Magnesia Insulation boosts operating efficiency of Plant Hammond, one of the South's largest and most modern private utility installations.

Insulating feed water line at Plant Hammond. Contractor for this job was Brooks-Fisher Insulating Company of Atlanta, Georgia.

J-M 85% Magnesia Insulation helps cut fuel rate 25% below national average

Officials of the Georgia Power Company were gratified when the coal rate of their new Plant Hammond worked out at 0.75 lb. per KW HR, 25% below the national average. In their annual *Electrical Industry Statistics, Electrical World* had reported that increased efficiency in the techniques of power production has lowered the average coal rate to 1 lb. per KW HR. in 1954.

An important factor contributing to Plant Hammond's high efficiency was the selection of insulation. Johns-Manville's 85% Magnesia was applied in the most economical thicknesses throughout the plant for all piping and equipment operating in its temperature range. At higher temperatures 85% Magnesia was used in combination with J-M Superex® diatomaceous silica insulation.

This is only one of thousands of case histories where J-M 85% Magnesia has helped industry achieve outstanding fuel savings and increased operating efficiency. In all types of manufacturing and processing plants it is the standard for temperatures to 600F . . . providing high insulating value, easy application, long life, initial low cost and minimum maintenance. Write today for further information on J-M 85% Magnesia and Johns-Manville's complete drawing-board-to-job-site insulation service. Address Johns-Manville, Box 60, New York 16, New York. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *first in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

More TECHNICAL BRIEFS

Begins on page 158

Steam turbines

Report of the investigation of two generator rotor fractures. *By C Schabtach, E L Fogleman, A W Rankin and D H Winne, General Electric Company.*

Two large 3600-rpm generator rotors burst during 1954 while rotating near rated speed. In both cases the fractures were of a brittle nature and occurred without warning. The materials were ductile by common standards and of a type widely used for generator rotors. Though the rotors were relatively large, many others of the same sizes have operated satisfactorily.

Exceptional nature of these accidents, coupled with importance of reliability in central-station plants, called for a complete and careful investigation of all features of the design, manufacture and material characteristics that might clarify cause of the trouble.

Investigation showed the two bursts were caused primarily by unusual and severe stress concentrations, combined with characteristics of the materials from which the rotors were made. Alloy segregation, in string-like regions of above-average alloy content, contributed to the cause of both bursts. Hydrogen content of both rotors caused the ductility of the material to be lowered significantly.

Study confirmed the soundness of the normal design features and the adequacy of the materials specified. With improved practices that will henceforth eliminate particular differences which were the major causes of the two bursts, there is no reason to believe that reliable units of still larger capacity cannot be built. *ASME paper No. 55-A-208.*

Report of the investigation of the turbine wheel fracture at Tanners Creek. *By A W Rankin and B R Seguin, General Electric Company.*

Early in January 1953, the 1800-rpm low-pressure turbine element of the No. 1 unit at Tanners Creek station of the Indiana and Michigan Electric Co suddenly went into violent vibration. The front standard—which contains the No. 1 bearing, thrust bearing, hydraulic cylinder and governing mechanism—cracked, and the resulting oil leakage caused a fire in the station.

When the turbine was opened for inspection, it was found that a segment of about 160 deg had broken out of the first-stage (reheat) wheel of the intermediate-pressure turbine section.

Review of all investigations of this turbine indicates that the most probable cause of this fracture was a combination of residual stresses that were not removed by tempering and stress-relief heat treatments, an unusually low long-time, high-temperature ductility, and thermal stressing of the first-stage wheel due to admission of wet steam. Improved practices have been introduced to avoid the recurrence of difficulties due to any of these causes. *ASME paper No. 55-A-210.*

Directions for ordering papers on p 234

Acceptance guides for ultrasonic inspection of large rotor forgings. *By A W Rankin and C D Moriarty, General Electric Company.*

Acceptance guides presented in this paper are based on design and manufacturing experience with turbine and generator rotor forgings in the weight range of about 20,000 to 150,000 lb. These guides recognize fundamentally the extreme difficulty of producing forgings in this weight range completely clear of ultrasonic reflections.

But the guides furnish reasonable and conservative assurance against the acceptance of forgings containing injurious defects. They provide an outer line below which cracked forgings have not been encountered, an inner line which is well within the outer line, and a trepanning policy for the evaluation of forgings whose number/magnitude lines are outside either the inner or outer lines. *ASME paper No. 55-A-194.*

First commercial supercritical-pressure steam turbine—built for the Philo plant. *By C W Elston and R Sheppard, General Electric Company.*

This paper describes essential design features of a 125,000-kw 3600-rpm tandem-compound double-flow steam turbine designed for steam conditions of 4500 psig, 1150-F initial temperature, 1050 F at the first reheat and 1000 F at the second reheat. Engineering objectives, problems and solutions are emphasized more than the description of design details. *ASME paper No. 55-A-159.*

Steam turbine-generator operating and maintenance methods of The Southern California Edison Company. *By C L Sidway and C M Clevenger, The Southern California Edison Company.*

The methods outlined in this report are the result of years of progressive development and reflect predominant characteristics of the system which they serve. Policies and procedures outlined have been in effect on this system since 1945. During this period no generators have failed in service. *AIEE paper No. 55-119.*

Considerations in the mechanical design of high-temperature steam turbines. *By W E Trumpler Jr and E A Fox, Westinghouse Electric Corp.*

Design of high-temperature utility steam turbines involves more than substitution of numbers into formulae. Pure mathematical extrapolation of creep test data must be tempered by judgment born of experience with materials involved and an understanding of service requirements.

Use of plastic-flow concepts will result in a more reliable prediction of true strength of a structure operating at elevated temperatures. Metallurgical and mechanical aspects are considered in light of practical design and construction. *ASME paper No. 54-A-234.*

Eccentricity, vibration and shaft currents in turbine generators. *By L T Rosenberg, Allis-Chalmers Manufacturing Co. AIEE paper No. 55-121.*

Experience in testing large steam turbine-generators in central stations. *By E M Kratz, General Electric Company. ASME paper No. 54-A-258.*

Analysis of slip damping with reference to turbine-blade vibration. *By L E Goodman and J H Klumpp, University of Minnesota. ASME paper No. 55-A-80.*

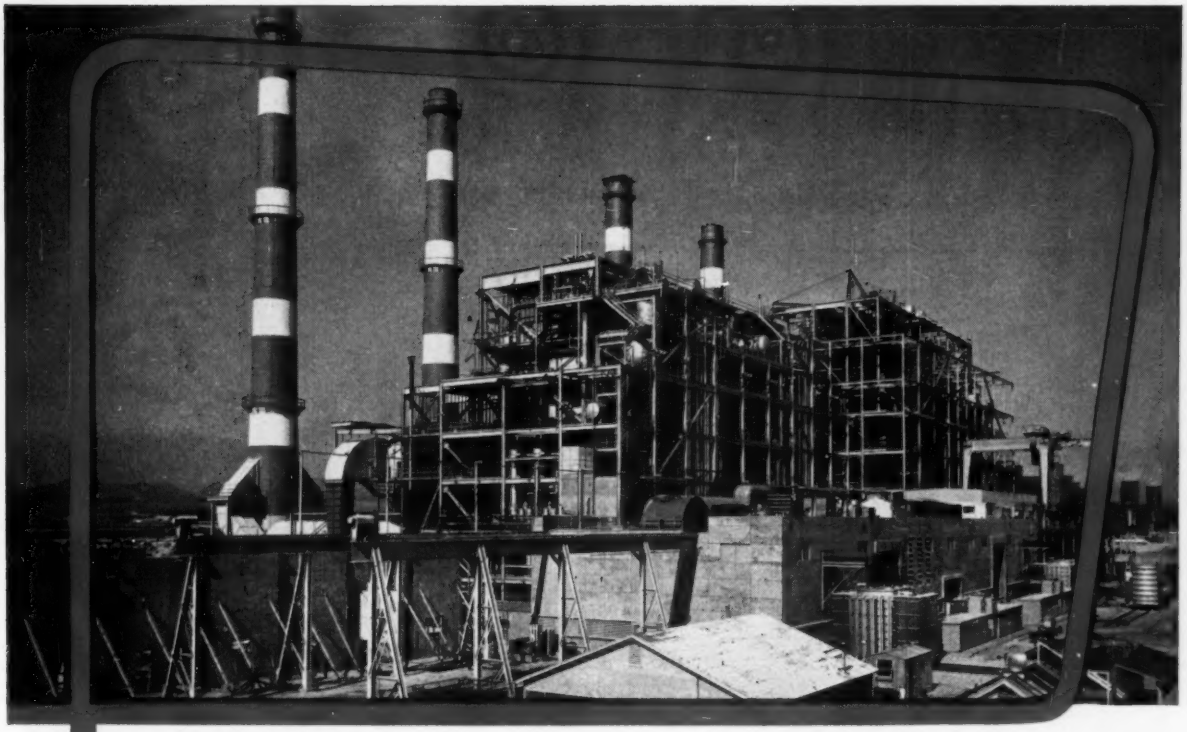
Steam plants

Plant management and other factors affecting maintenance costs in steam generating stations. *By V F Estcourt, Pacific Gas and Electric Company.*

Though direct maintenance costs in thermal power stations comprise only a small percentage of total production cost, replacement power costs while a generating unit is out of service for maintenance are also chargeable to the over-all cost of the job. This may amount to considerably more than the entire repair cost.

Control of maintenance cost is concerned principally with those factors that influence ability of the plant to stay on the line. This includes a wide

(*Continued on page* 224)



KEY-KAST® "Y" FITTINGS to SERVE MAIN STEAM LINE in NEW LOS ANGELES POWER PLANT

Answering the need for extraordinary strength and endurance, KEY-KAST specially designed wyes have been installed in the main steam lines at the Valley Steam Plant Unit #4, City of Los Angeles, Department of Water and Power. The dependable performance of KEY-KAST wye fittings is achieved through careful engineering and special emphasis on:

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3. Complete quality control involving:
    1. 100% Radiography to A.S.T.M. Specification E-71, Class 2.
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4. Greater allowance against erosion—extra thickness at critical area.

SPECIAL NOTE: We invite your inquiries for main steam wyes, laterals, elbows, etc. In submitting your inquiries, please list design temperature pressure conditions, pipe or tube schedule or wall thickness and material.

Pipe fabrication in this modern West Coast power plant by Associated Piping & Engineering Co., Inc.

JOB DETAILS

FITTING:	14"x12"x12" 120° wye
MATERIAL:	2¼% chrome, 1% moly. Grade WC9
DESIGN CONDITIONS:	1925# @ 1000°F.

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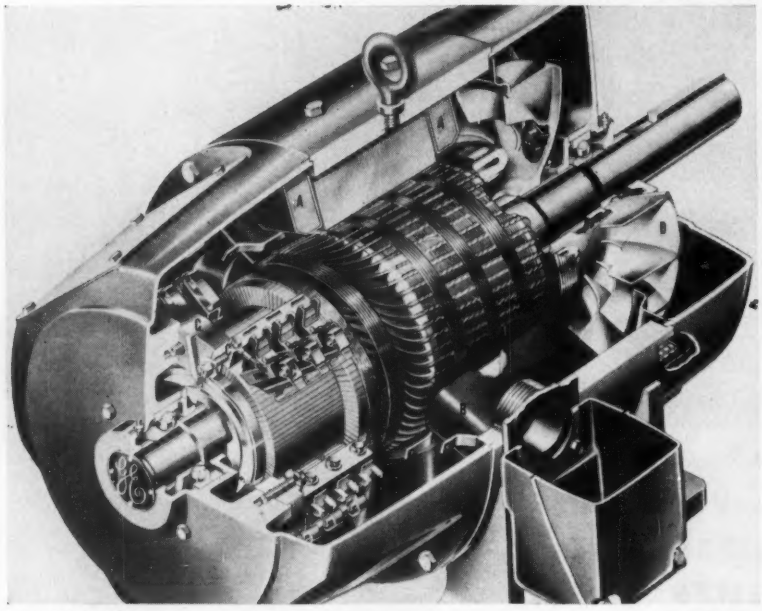
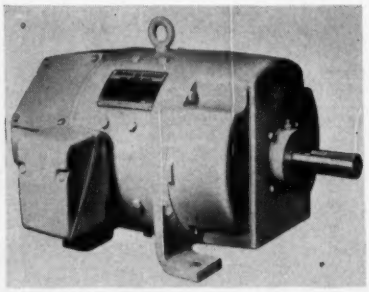
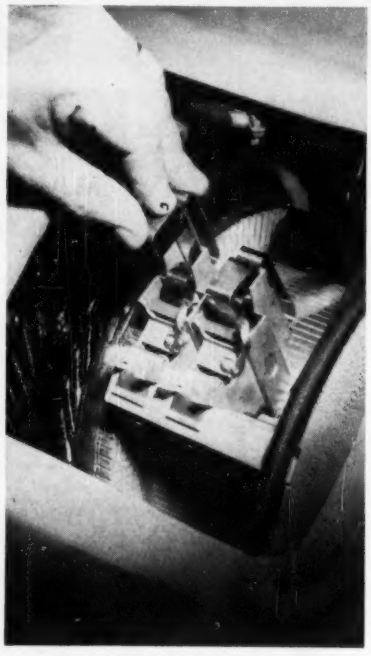


CUTAWAY VIEW shows new direct-current motors, rated from one to 150 horsepower



STANDARD MOTOR has a rolled steel frame with cast iron, dripproof endshields



LARGE HAND HOLES permit access to commutator, simplify brush replacement

Dc motors and generators meet industrial needs

401 • *Kinamatic* line of direct-current motors and generators—the first complete industrial line built to latest NEMA standards for future design—is said to meet modern needs for faster, more continuous, more automatic production. All motor ratings from one to 150 hp and all generator ratings from ¾ to 100 kw are available.

Speed is adjustable by armature-voltage control, field-strength control or any combination of both. Higher base speeds are available. For constant horsepower applications, higher top speeds can be obtained through field-strength adjustment.

The motor can also be applied where extra power at high speeds is needed. Through "forcing"—the application of overvoltage—many ratings can operate at proportionately higher speeds and horsepower. The unit can operate at any speed below base speed—including stalled torque.

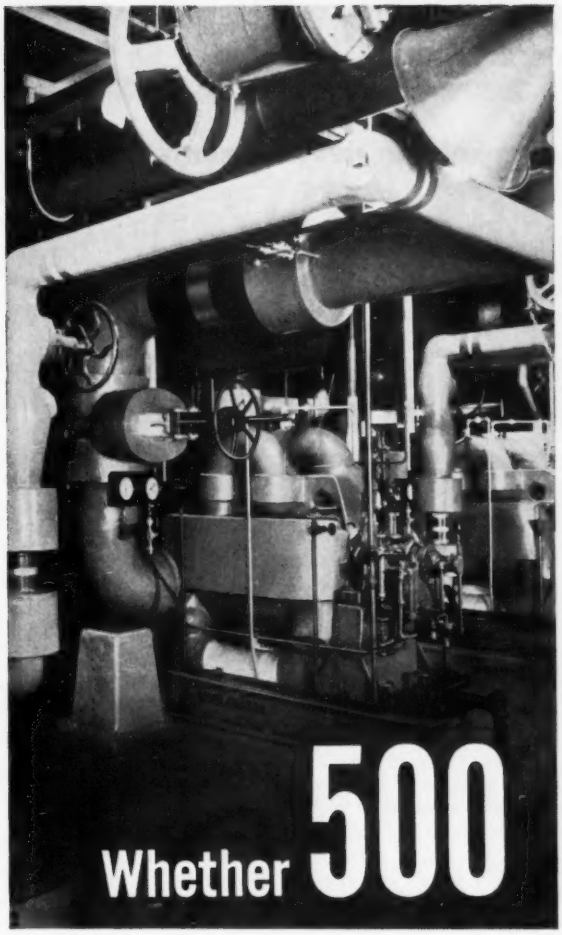
All standard *Kinamatic* motors and generators have dripproof enclosure and are supplied with a guaranteed 15% service factor. Class B insulation is supplied throughout. Reduced armature inertia (Wk^2) permits faster speed of response, according to manufacturer.

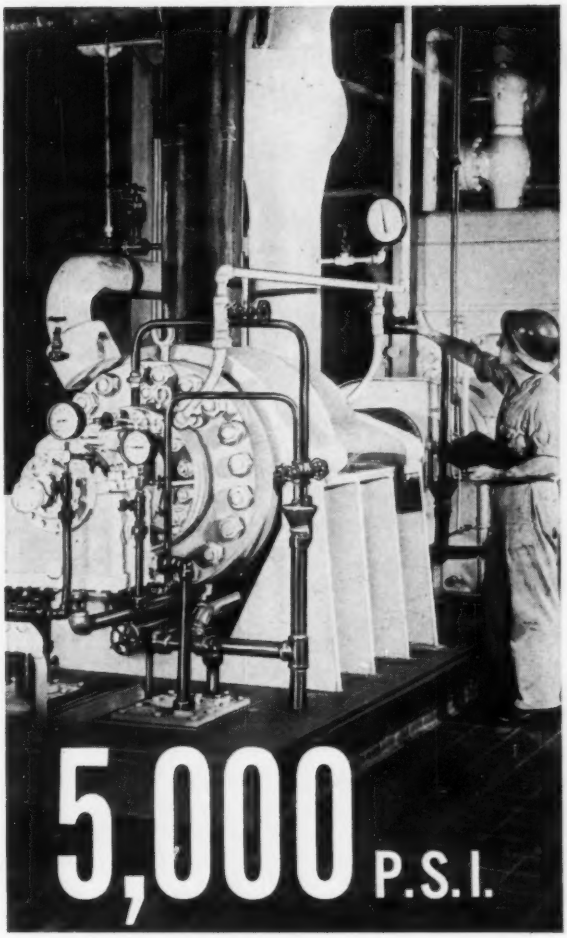
Design features outlined as significant by the manufacturer are shown in the cutaway photo, above. Figures *A* and *B* respectively show exciting and commutating field coils insulated throughout with mica, glass and other inorganic materials—with coils encapsulated in a heat-resistant polyester compound. *C* identifies the brush rigging—with brush holder yoke of heat-and-moisture-resistant polyester glass heavily ribbed for maximum rigidity; and the bronze corrosion-resistant brush holders—with broached carbon ways, mounted on rigid square steel studs. Any brush holder may be removed without disassembly of the motor. Both radial and axial adjustment can be made, permitting easier maintenance.

Newly designed brush springs allow for changing of brushes with one hand. Springs maintain constant pressure throughout brush life. *D* marks the lightweight aluminum fan and improved ventilation system that manufacturer claims will provide superior heat transfer at all speeds.

General Electric Company, Schenectady 5, New York

For news of recent mechanical transmission developments, turn page ►





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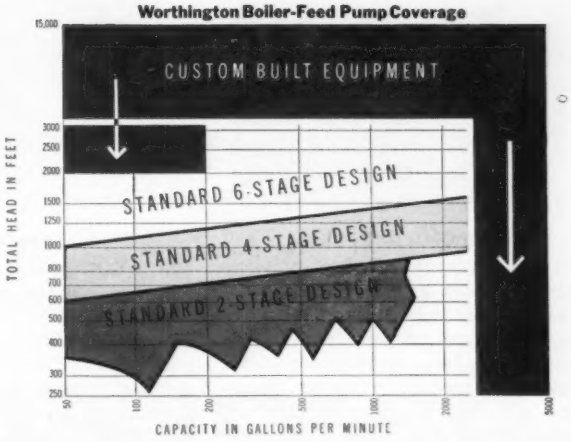
Boiler Feed Pump system-wise experience protects you

No one knows more about coordinating your steam power system than your Worthington engineer. He represents the leading manufacturer of this type of equipment. He brings to every boiler feed pump installation, no matter how small, the same experience that produces the world's fastest, highest pressure units. With any head, any capacity, any boiler feed pump problem, call your Worthington engineer. His system-*wise* experience will protect your investment. Worthington Corporation, Pump Department, Harrison, N. J.



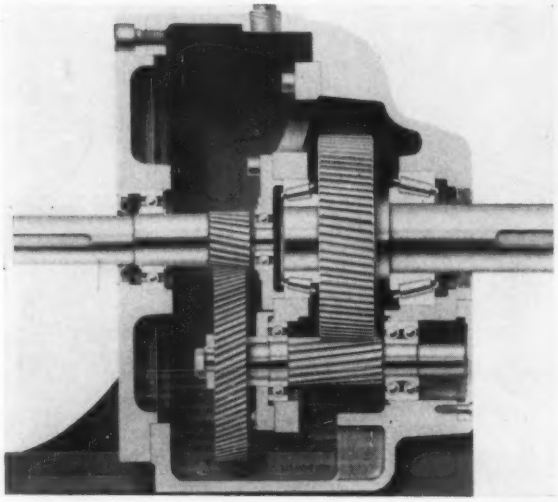
WORTHINGTON

WORLD'S BROADEST LINE OF BOILER FEED PUMPS

More EQUIPMENT NEWS

Begins on page 162

Mechanical transmission—five problem-solving developments

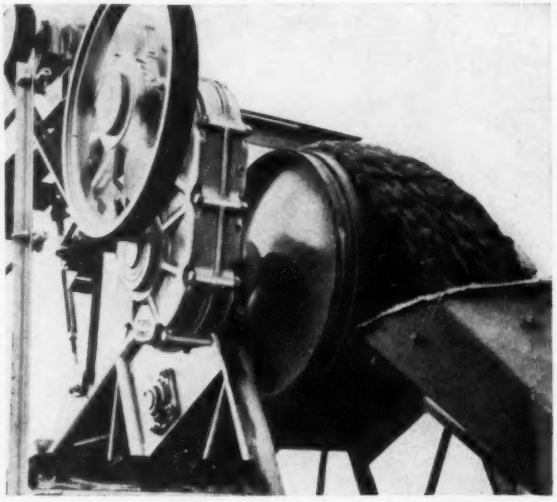


Heavy-duty in-line helical gear drives

402 • These units are claimed to combine a high degree of standardization with ability to stand up in heavy-duty service. Double-reduction drives are available in ratios from 6.2 to 1 through 38.4 to 1, with capacities to 118 hp. Triple-reduction drives are made in ratios from 47.1 to 1 through 292 to 1, with capacities to 20 hp.

One-piece cast iron housings, with oil seals at shaft openings, prevent oil leakage. Space requirements and layout problems are minimized by locating output and input shafts in the same horizontal and vertical planes.

Link-Belt Co, 307 N Michigan Ave, Chicago 1, Ill.



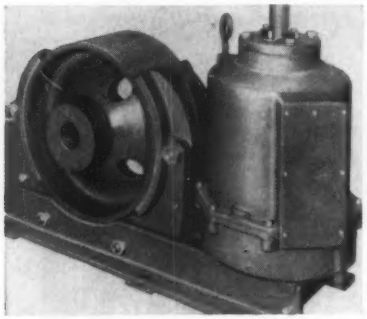
Shaft-mounted speed reducers—1 to 60 hp

403 • With addition of two models, company's *Torque-Arm* line of shaft-mounted speed reducers is offered with capacities from 1 to 60 hp and output speeds from 12 to 365 rpm.

New size No. 8, in the double-reduction series, has a capacity of 60 hp at 100 rpm, AGMA rating. It can be mounted on shafts up to 5-in. diameter. New No. 11 size has capacity of 1.3 hp at 100 rpm.

No foundation, flexible couplings or sliding base is required. Units mount directly on shaft—*Torque Arm* is fastened to any fixed object, anchoring the reducer.

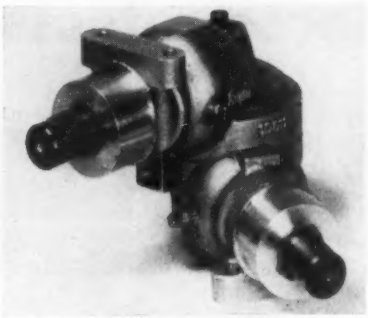
Dodge Manufacturing Corporation, Mishawaka, Ind.



Dc magnetic brakes

404 • Self-adjusting feature of these units decreases maintenance and down time, provides longer lining and wheel life. Manufacturer states that regardless of lining wear or wheel expansion, brake shoe remains in correct adjustment and alignment with wheel. Once torque setting is made for a given application, it need never be changed. Sizes to fit all dc motors.

Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.



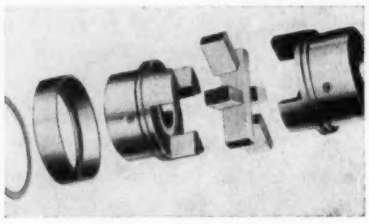
New geared joint

405 • Unit is actually an adjustable gear box that transmits torque at any angle from 45 to 315 degrees. Primary use is for making sharp bends in valve remote control linkages using flexible shafting or reach rods.

Needle bearings permit the unit to be used for power applications with speeds up to 500 rpm. Further details on request to the manufacturer.

Stow Manufacturing Company, 181 Shear St, Binghamton, N. Y.

For more details on these items, use post cards p 171. Identify your request with item number.



Flexible couplings

406 • Lubrication-free units are especially suited to centrifugal and impeller pumps and other installations where radial removability is required.

Sizes range from 2.58 to 29.6 hp at 100 rpm. All units feature cushions that can be reversed on unidirectional loads to double their service life.

Lovejoy Flexible Coupling Co, 4870 W Lake St, Chicago, Ill.

Industrial pump news, turn page ►

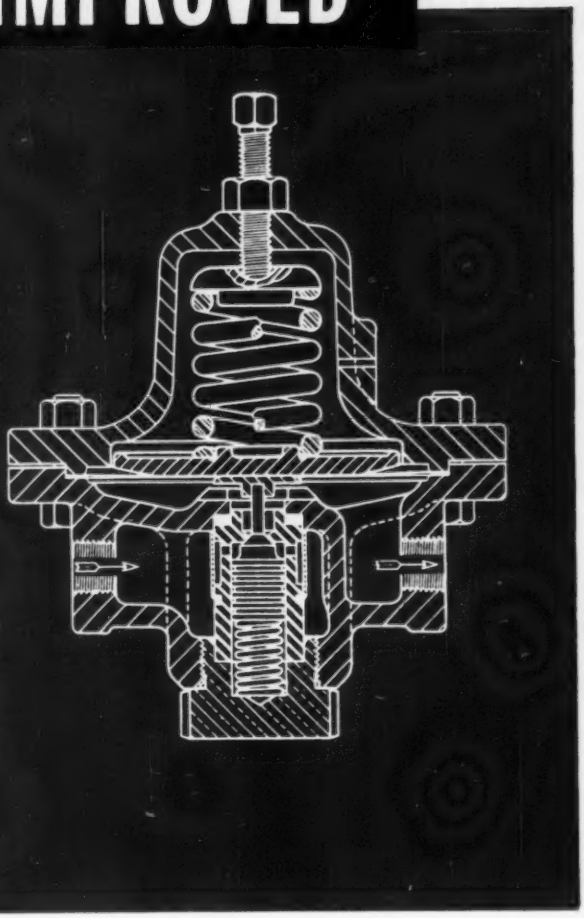
REDESIGNED—IMPROVED

THE CASH STANDARD TYPE D

Pressure Reducing and Regulating Valve

NOW . . . half the number of bolts saves maintenance time and . . . gasket seal at diaphragm flange provides easier pressure range conversion.

BUT . . . performance-wise it is still the same dependable valve that CASH STANDARD has offered for over 35 years to provide precise automatic control of most liquids, steam and gases.



- Internal working unit still interchangeable with other models
- Interior easily accessible for quick cleaning or replacement
- Simple construction—minimum of parts
- Built-in strainer
- Available in iron, bronze, steel or stainless steel body, and bronze, stainless steel, nitralloy or monel trim
- Screwed ends, sizes ¼" to 2"

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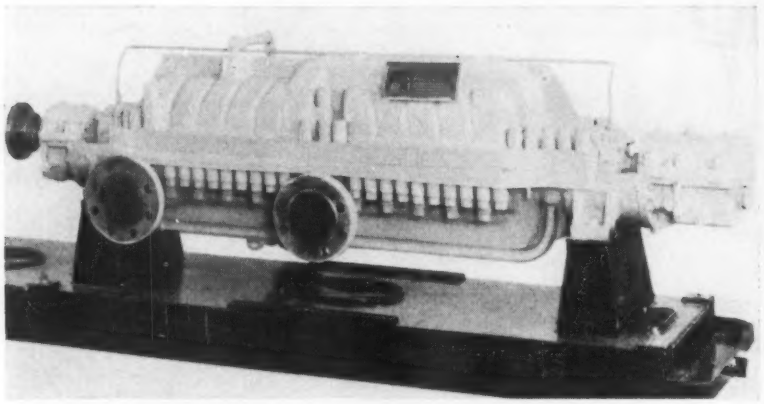
More EQUIPMENT NEWS

Begins on page 162

Five industrial pumps designed for varied applications

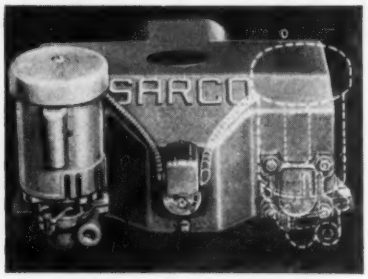


Boiler feed pump fits medium-size power plant needs

407 • *Model DVMX* boiler feed pump is engineered primarily for medium-sized communities and cooperative power companies. It handles capacities to 2200 gpm and heads to 3000 ft.

Horizontally-split double-volute design produces radial balance of the pump at all capacities, manufacturer states. All volutes and water passages between stages are an integral part of each casting. Impellers are arranged in equally opposed groups, producing hydraulic axial balance, eliminating use of high-pressure drop balancing devices. Nozzles are located in lower half of pump—permitting removal of top half and rotating element without disturbing the piping. Self-contained oiling system helps to simplify maintenance. A mechanical seal may be used to replace standard packing in the stuffing box. Full details on request.

Byron Jackson Pumps, Box 2017A, Terminal Annex, Los Angeles 54, Calif.



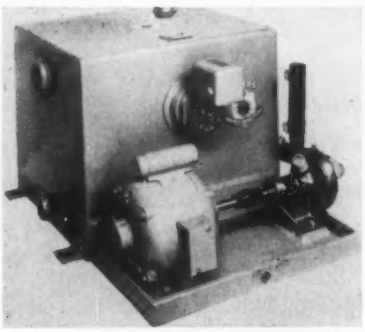
Condensate-return pump

408 • These close-coupled, bronze-fitted pumps are furnished with a 12-gallon cast iron receiver. Capacity is 2000 to 8000 sq ft edr and 3450 rpm. Features claimed include: easy conversion from single to duplex; low 7½-in. inlet; mechanical seal; dynamically-balanced enclosed bronze impeller.

No sub-base is required. Unit can be disassembled for inspection without removing pipe connections. For additional information request bulletin 1460 from the manufacturer.

Sarco Co, Inc, Dept P, Empire State Bldg, New York 1, N .Y.

For more details on these items, use post cards p 171. Identify your request with item number.

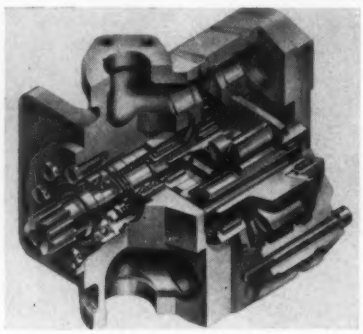


Centrifugal condensate pump

409 • All-bronze unit handles any load to 8000 sq ft at 20 psi. It does not require a pit—even though return pipes are no more than a foot above the floor. Non-clogging open impeller, stainless steel shaft, life-sealed ball bearing are listed features.

Flexible coupling and pipe connections isolate the pump, eliminate wear.

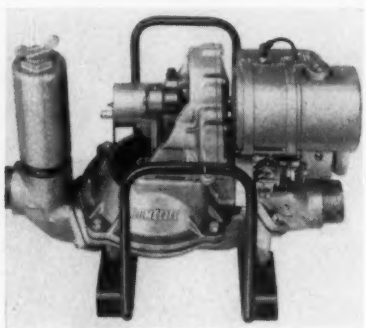
Walter H Eagan Co, Inc, 2336 Fairmount Ave, Philadelphia, Pa.



Heavy-duty hydraulic pump

410 • *Series 3600* pumps are engineered for installation where space is extremely limited and where adverse conditions exist. They will deliver 65-90-110 gpm at 1200 rpm, depending on model. Speeds range to 2000 rpm; pressures to 1500 psi and fluid horsepower to 150 hp. Companion control valves are also available.

Hydreco Div, N. Y. Air Brake Co, 1100 E 222nd St, Cleveland, Ohio



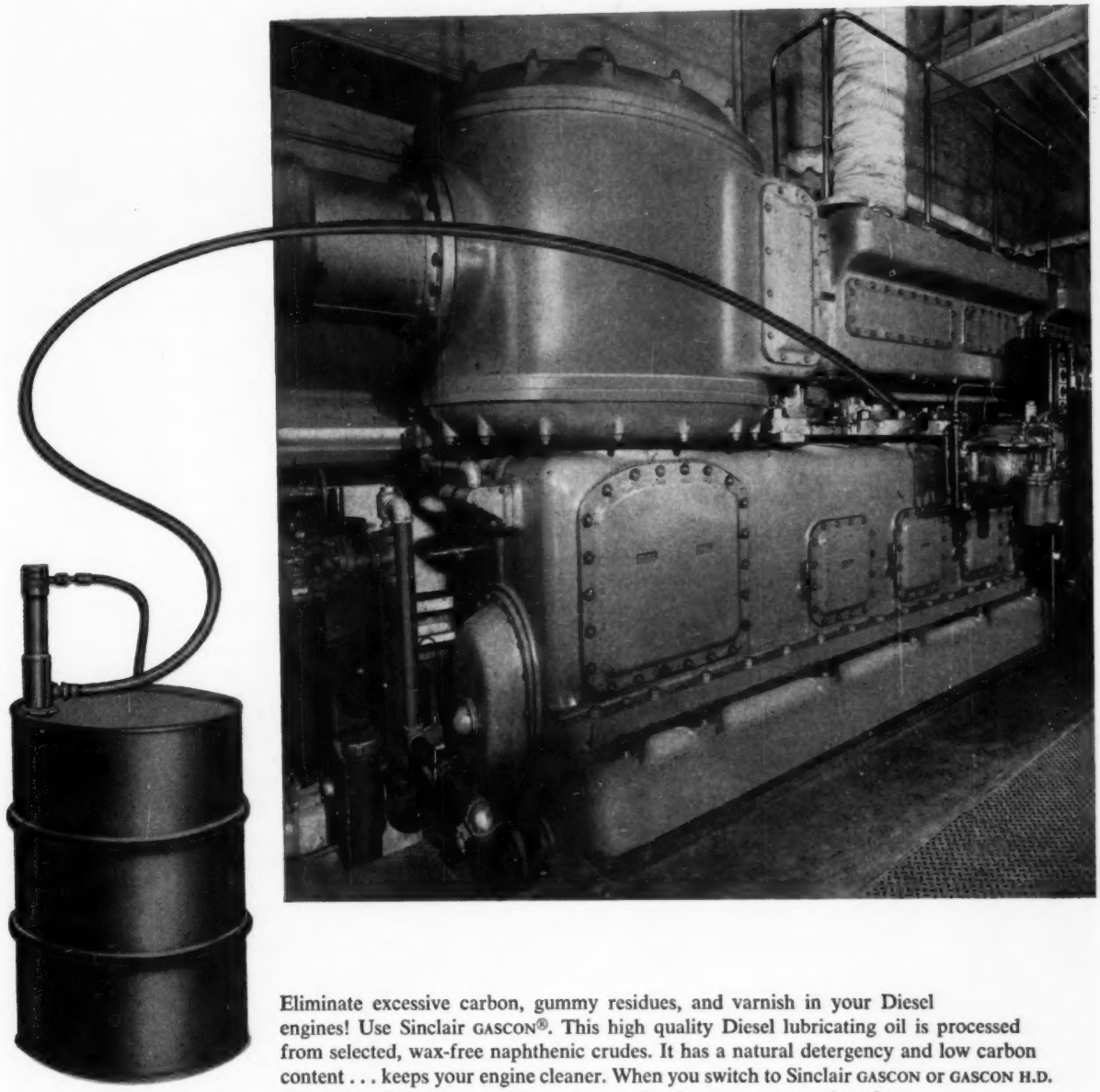
Portable diaphragm pump

411 • Designed for heavy-duty pumping—mud, muck, sand and sewage—this unit will run six hours at full capacity on one gallon of fuel. Weight is 120 lb—making it possible to set up pumping operations in any location. Completely self-priming, it will dry-prime up to 15 ft. Pumping capacity is 5000 gph; total head is 50 ft.

Homelite, 75 Riverdale Ave, Port Chester, N. Y.

New overload indicator, other electrical items, turn page ►

Check Carbon!



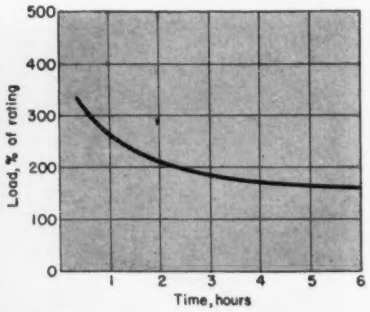
Eliminate excessive carbon, gummy residues, and varnish in your Diesel engines! Use Sinclair GASCON®. This high quality Diesel lubricating oil is processed from selected, wax-free naphthenic crudes. It has a natural detergency and low carbon content . . . keeps your engine cleaner. When you switch to Sinclair GASCON or GASCON H.D. you know that pistons, rings, valves and exhaust ports stay free from carbon, gums and varnish.

No matter what design of engine you're operating, you'll be 'way ahead with Sinclair's complete line of Diesel lubricants. Contact your local Sinclair Representative now for full details, or write Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N.Y.

SINCLAIR GASCON OILS

More EQUIPMENT NEWS

Begins on page 162



TYPICAL load-time curve for the indicator starting at no load-25 C ambient

Overload indicator for distribution transformers

412 • *Type TD* overload indicator for conventional distribution transformers keeps a permanent and accurate record of overload hours based on copper temperatures. It aids in prediction of transformer life, gives advance warning for changeout scheduling and is easy to read from the ground, according to the manufacturer.

Unit consists of three parts: (1) control thermostat, installed so it responds directly to copper temperature (2) motor or timing mechanism that permanently records number of overload hours on a dial (3) signal light that serves as an auxiliary warning.

Timing motor and signal light are supplied by an auxiliary winding that is not exposed to surges.

Thermostat actuates timing mechanism whenever thermal capability of the windings is exceeded. Timing motor continues to run as long as overload is present and records on the dial the number of hours transformer has operated above its thermal capability. Signal light also turns on—remains on only as long as overload persists. When winding temperature drops, timing motor shuts off—but indicator does not reset. It continues to show a cumulative total of overload hours.

Bimetallic, hermetically-sealed thermostat is placed inside insulated cell. This cell is inserted into a metal tube that in turn is placed in close contact with a current-carrying conductor.

Timing mechanism consists of a low-voltage hysteresis motor mounted integrally with a gear train that drives the dial pointer. Dial will record a total of 300 overload hours.

Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

For more data on these items, use post cards page 171. Identify your request with item number.

Isolated phase bus has telescoping cover

413 • Isolated phase bus design offers new advantages for safely conducting large concentrations of power. All-welded, aluminum basic assembly is factory fabricated—shipped in one piece.

Normal mounting conditions permit use of two supporting rings for each basic assembly, giving both extreme rigidity and quickest alignment. Easy opening for inspection is gained by a telescope-type two-way sliding cover with V-clamp closure. Closure requires but one single-piece o-ring gasket in each cover joint. Completed structures have smooth inside surfaces, offering no pockets to collect moisture. For additional information request bulletins 10004-A and 10004-B from the manufacturer.

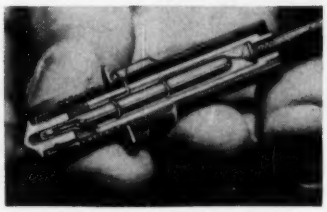
I-T-E Circuit Breaker Co, 19th & Hamilton, Philadelphia, Pa.

Portable ac power plants in sizes to 3500 watts

414 • These units are available in sizes of 1000, 1500, 2500 and 3500 watts. Weights range from approximately 90 lb on the 1000-w model to less than 280 lb on the largest model. The units are equally adaptable for dependable emergency or to operate power tools for maintenance or construction. The 2500- and 3500-w units are dual 110/120 volts as standard. Request details.

Katolight Corporation, Box 891, Mankato, Minn.

Don't miss this item . . .

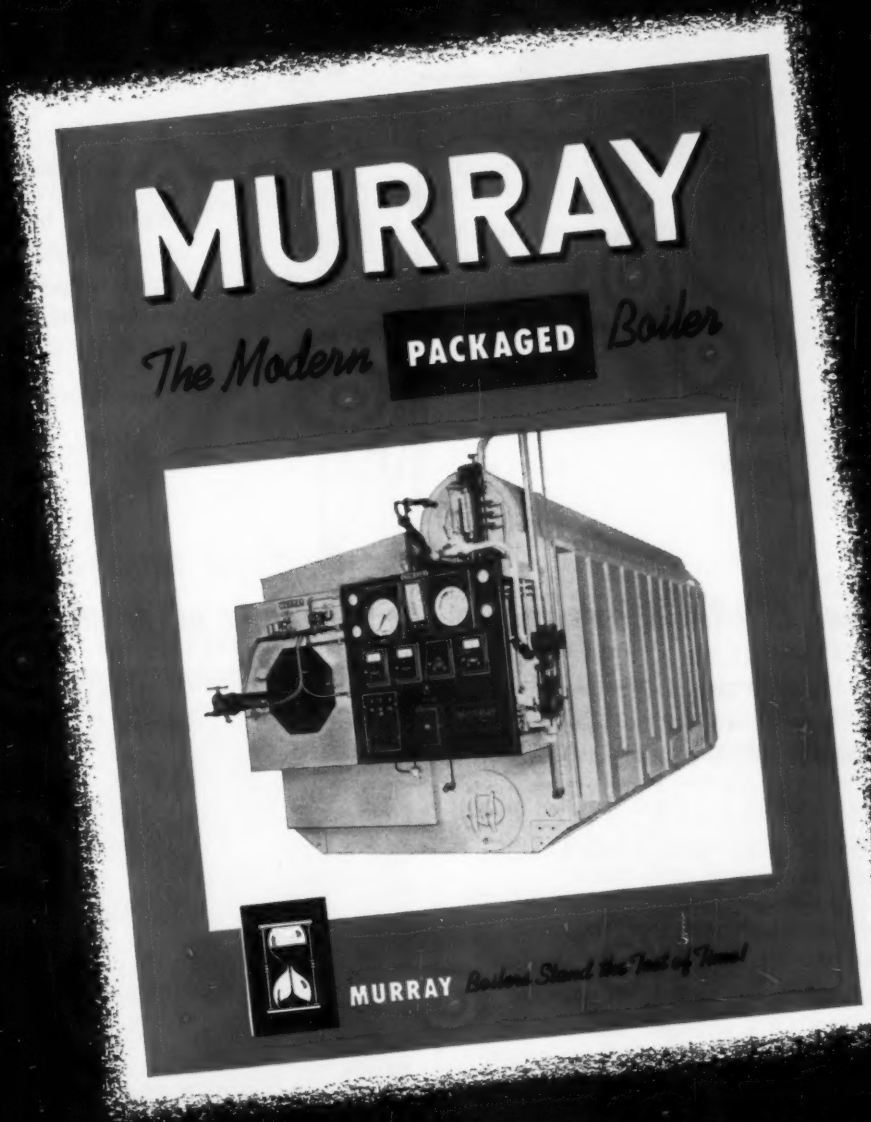


Bearing overheat detector . . p 176

. . . or these and the many others appearing on pages noted below:

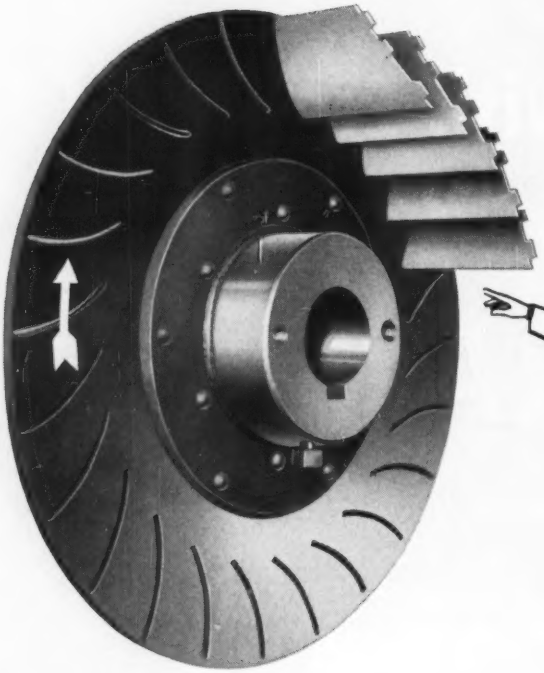
Belt conveyor idler . . . . . p 178
Packaged boiler unit . . . . . p 180
Carbon-monoxide detector . . . . . p 182
Portable hot-oil heater . . . . . p 184
Constant support hangers . . . . . p 186
50-kvar power capacitors . . . . . p 188

Dependability with Economy!



MURRAY packaged boilers are designed to meet today's need for compact, low cost, reliable heating and generating plants . . . When you install a MURRAY packaged boiler, you get the benefit of over 85 year's experience exclusively in the manufacture of boilers and allied products . . . Write for new folder, "MURRAY, The Modern Packaged Boiler," which gives complete information.

MURRAY IRON WORKS COMPANY · BURLINGTON, IOWA



Something different (and decidedly better) distinguishes this wheel

ONE-PIECE blades extend THROUGH slots in the centerplate — then are welded both front and back on both sides of the centerplate.

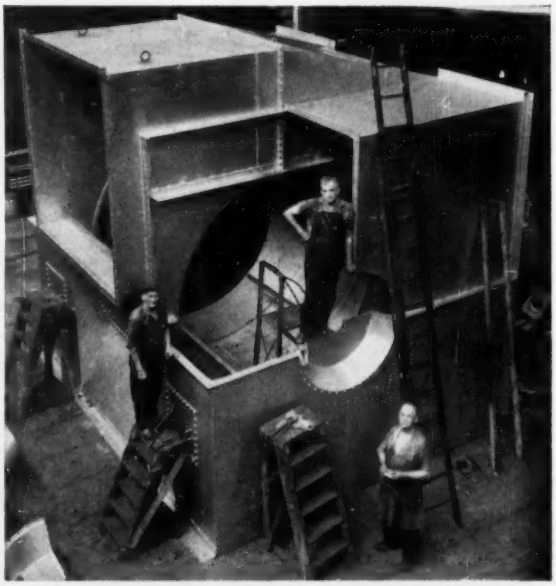
. . . a typical CLARAGE answer to the demands of mechanical draft

Sure, you can perhaps get by with lesser construction. That is, a wheel with separate blades on each side of the centerplate.

But our conviction is: there can be no compromising on the construction of a punishment-taking mechanical draft fan.

That's why, unlike wheels of other makes, the wheel for the Clarage Type RT fan is built as shown above. Clearly, this construction provides EXTRA strength that assures the user longer-lasting, trouble-free service.

Additional advantages of choosing Clarage Type RT equipment are shown in Catalog 901. Write for it today. CLARAGE FAN COMPANY, Kalamazoo, Michigan.



Clarage builds for many of the biggest and most exacting air handling jobs. This Type RT fan was constructed for induced draft service in a Porto Rican sugar refinery.

CLARAGE

. . . dependable equipment for making air your servant

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

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follow these easy steps

Preceding pages tell you what's new in plant equipment. Each item is numbered. For more details on any item, write its number here

New free bulletins are listed and numbered, beginning on back of this page. To order those you want, write POWER item number here — *do not use manufacturer's bulletin number.*

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AIR CONDITIONING, HEATING, REFRIGERATION, VENTILATION

1 **Draft inducers** for heating boilers and for power plants are described in bulletin I-56. Contains selection table, selection curves, full description of new features. L J Wing Mfg Co, Linden, N. J.

★ **Class III fans** especially designed for high-velocity air-conditioning systems are subject of bulletin DS-348-C. Units are also suited for industrial use. ★Request direct from manufacturer on your firm's letterhead. Trane Co, La Crosse, Wis.

2 **Refrigerating machine.** Illustrated 8-p bulletin 1426 describes the *Tonrac* single-stage hermetic centrifugal unit. Includes construction details, typical installation, related equipment. American Blower Corp, Detroit 32, Mich.

3 **After cooler** removes moisture from compressed air and gas. Descriptive 8-p bulletin 130 contains photos, diagrams, application data. Niagara Blower Co, 405 Lexington Ave, New York 17, N. Y.

4 **Cooling tower,** induced-draft type, is subject of 4-p bulletin CT-56-1. Contains drawings, construction and operational details. Foster Wheeler Corp, 165 Broadway, New York 6, N. Y.

★ **Refrigeration equipment.** Complete data of *CenTraVac* centrifugal units is given in 50-p bulletin DS-399. Provides full engineering and capacity information on 20 *CenTraVac* sizes. ★Request direct from manufacturer on your firm's letterhead. Trane Co, La Crosse, Wis.

5 **Ceiling diffusers** for use in installations with high ceilings are described in 4-p bulletin F 7722. Includes performance data, physical characteristics, photos, diagrams. Barber-Colman Co, Rockford, Ill.

6 **Draft fans** for power plant operations. *Gales Airfoil* unit, with wheel diameters ranging from 30 to 98 inches in each of six different designs, are described in this bulletin. The Green Fuel Economizer Co, Inc, Beacon, N. Y.

COMPRESSORS

7 **Air and gas** compressors used in the process and chemical industries are shown in 8-p bulletin 3132-A. Includes data on centrifugal and reciprocating units for pressures from deep vacuum to 35,000 psi and capacities to 165,000 cfm. Ingersoll-Rand Co, 11 Broadway, New York 4, N. Y.

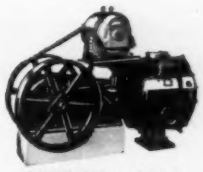
8 **Rotary portable** compressor delivering 900 cfm at 100 psi is described in 4-p bulletin 2313. Contains photos, design features, weights and dimensions. Ingersoll Rand Co, 11 Broadway, New York 4, N. Y.

(*Continued on page 214*)

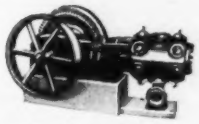
Heavy-duty
ES compressors

provide maximum efficiency in a
WIDE RANGE OF APPLICATIONS

. . . with unusual flexibility of drive and cylinder arrangements



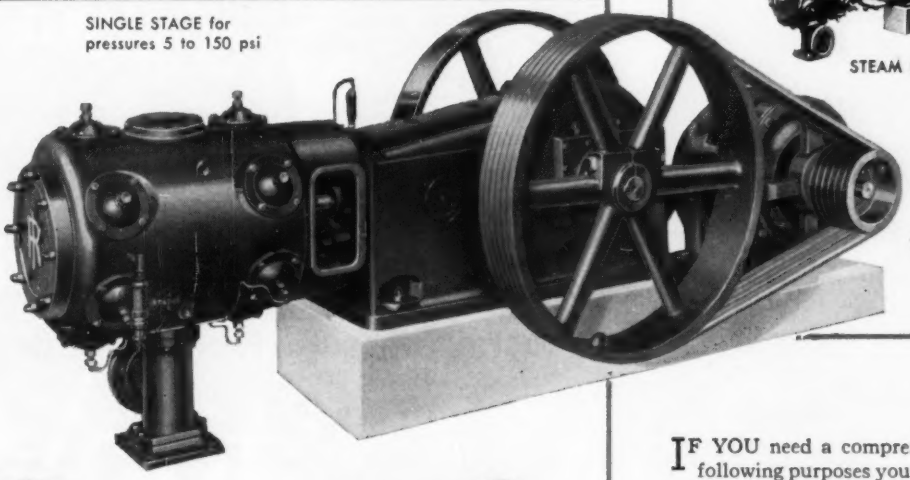
OVERHEAD MOTOR



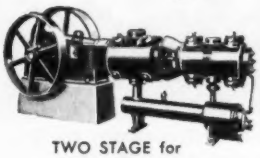
DIRECT-CONNECTED SYNCHRONOUS MOTOR

STEAM DRIVE

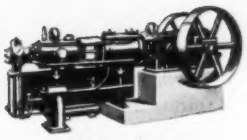
SINGLE STAGE for pressures 5 to 150 psi



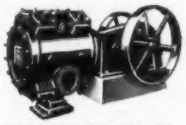
V-BELT DRIVE



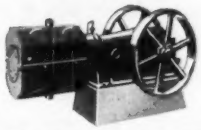
TWO STAGE for 150 to 500 psi



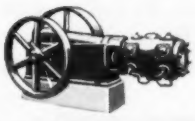
THREE STAGE for 500 to 2500 psi



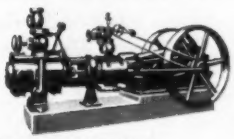
DRY VACUUM PUMPS . . . single or two stage



STEAM-PRESSURE BOOSTERS



NON-LUBRICATED CYLINDERS for oil-free air or gas



REFRIGERATION UNITS for ammonia or other refrigerants

IF YOU need a compressor for any of the following purposes you should consider the Type "ES" compressor . . . a standardized, yet extremely flexible compressor built by Ingersoll-Rand, the pioneer compressor builder.

- To compress air or gas to any pressures between 5 and 2500 psi, or for pulling vacuums. (Stock cylinders are normally available for all frame sizes, see illustrations.)
- For capacities requiring from 7½ to 150 horsepower. (Six frame sizes are available.)
- For continuous full-load operation day after day, week after week.
- For handling poisonous, inflammable, or other gases where leakage must be avoided.
- Where compressed air or gases must be free of all traces of oil. (Type NL cylinders require no oil, glycerine, grease or water for lubrication.)
- Where a future change in pressure conditions may call for a change in cylinder sizes.
- Where power cost is an important factor.
- To act as an economical standby unit for larger compressors whose full capacity is not required at all times.

Ingersoll-Rand

1-347 11 Broadway, New York 4, N. Y.

COMPRESSORS • CONDENSERS • AIR & ELECTRIC TOOLS • TURBO BLOWERS • PUMPS • ROCK DRILLS • GAS & DIESEL ENGINES

George Edwards

shares an Easter message from a reader

► LAST JANUARY I went to New York for one of my every-so-often visits with Lou Rowley and the boys on the POWER staff. The atmosphere of informal, organized confusion in the office never fails to fascinate me and, as usual, I thoroughly enjoyed my day. I had a sort of preview of coming POWER attractions and my head swam with details of what's going on in industry. Lou pleasantly surprised me by having Phil Swain meet us for lunch. As you know, Phil has retired and is a consultant in technical writing and speaking. If you're planning on hearing one of his talks, you're in for a treat.

On the train going home, I read some mail Lou held knowing I was coming in. I often wish I could meet all of you who write to me. I enjoy your letters and appreciate the items you send for my scrapbook.

Ted Gardner, down in South Carolina, enclosed this with his letter. It's new to me, but Ted says he saw it somewhere years ago and its origin is unknown. I think you'll like it. It's called "A Brief Biography."

"This is about a man who was born in an obscure village, the child of a peasant woman. He grew up in another obscure village. He worked in a carpenter shop until He was thirty, and then for three years He was an itinerant preacher. He never wrote a book. He never held any office. He never owned a home. He never had a family. He never went to college. He never travelled two hundred miles from the place where He was born. He never did any of the things that usually accompany greatness. He had no credentials but Himself.

"While still a young man, the tide of popular opinion turned against Him. His friends ran away. One of them betrayed Him. He was turned over to His enemies. He went through a mockery of a trial. He was nailed upon a cross between two thieves. While He was dying, his executioners gambled for the only piece of property He had on earth, His coat. When He was dead, He was taken down and laid in a borrowed grave through the pity of a friend.

"A little over nineteen and a half centuries have come and gone, and today He is the centerpiece of the human race and the leader of the column of progress. We are far within the mark when we say that not all the armies that ever marched, nor all the parliaments that ever sat, nor all the kings that ever reigned, put together, have ever affected the life of man upon this earth so powerfully as has this one solitary LIFE."

STRONGER and SAFER for every high pressure pipeline duty...

...because they are **drop forged by Vogt**

Send for Catalog F-9

Constantly imitated but never duplicated, Vogt drop forged steel fittings and flanges have unmatched strength and toughness for your most severe pipeline duties. Laboratory controlled materials and Vogt's special forging techniques assure products which are always uniform in structure, fine grained, and free from porosity. Thereby the shocks and stresses imposed by high pressures and high temperatures are easily withstood, and with stubborn resistance to erosion and corrosion. Consult Catalog F-9 for our complete line of fittings and flanges.

For a copy of Vogt Catalog F-9 address Dept. 24FP.

HENRY VOGT MACHINE CO., P.O. BOX 1918, LOUISVILLE 1, KENTUCKY

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Vogt

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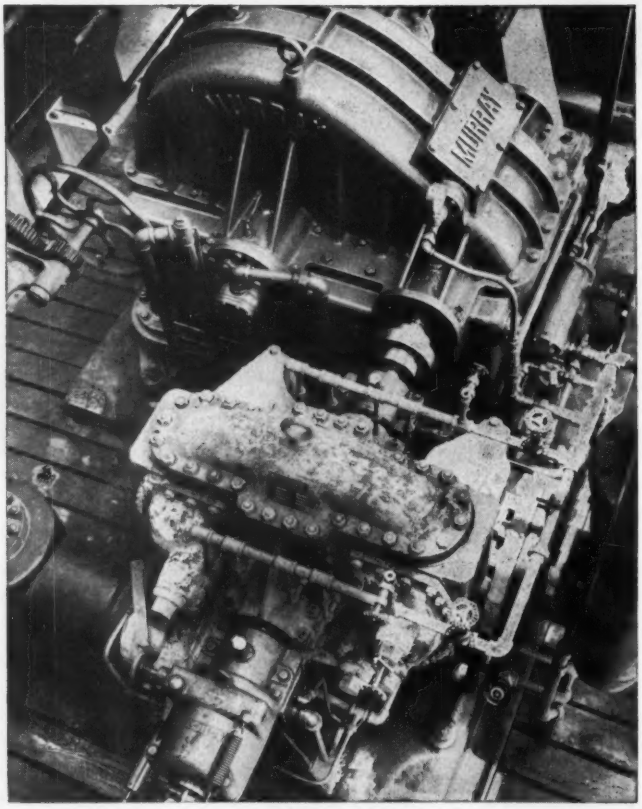
Fittings and Flanges

Murray Turbines

OUTDOOR INSTALLATION?



THE RIGHT ANSWER—MURRAY

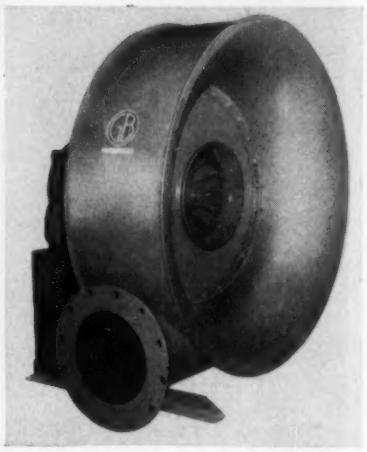
The turbo-gear unit shown above has been installed outdoors with virtually no weather protection for many years. The turbine exhausts to a process line carrying 170 psig pressure. Yes—for rugged applications—the right answer—MURRAY.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

More EQUIPMENT NEWS

Begins on page 162



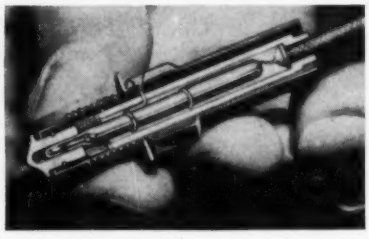
Blower delivers 2650 cfm

421 • This turbo is a design C, 28-oz, 30-hp unit capable of delivering 2650 cfm. Designed primarily for oil burner operation its perfect circle housing has a large diffusion area. Velocity pressure is converted to static pressure within the housing itself. Venturi design of inlet side reduces intake shock, facilitates smoother air flow, according to manufacturer.

Recommended for multiple burner and multiple outlet applications it may also be used for pneumatic conveying of materials (where these materials do not go through the fan), burner applications, cupola furnaces, aeration, chemical and food processing. When properly equipped with sealing devices the turbo may be used as a gas booster. It may be supplied with wheels made from aluminum, mild steel or stainless steel. Discharge is rotatable. For further information request bulletin CB108R from the manufacturer.

General Blower Company,
Morton Grove, Ill.

For more details on these items, use post cards p 171. Identify your request with item number.



Overheat warning control

415 • Miniature control is used on industrial machine bearings, airplanes and equipment where an accurate overheat warning signal is needed. Inside the unit's metal housing is a sensitive mercury contact thermostat that will detect a bearing overheat temperature of 275 F and light a warning signal in the cockpit in less than four seconds from the time the overheat condition takes place. No amplifier, relays or bridge pickup box is needed to work

New Balanced Mobil D.T.E. Oils—

Socony Mobil D.T.E. Oils have long set the standard for performance of hydraulic and circulating oils. Today, after many years of continuing laboratory research and several years of exhaustive field tests, we announce a completely new line of Mobil D.T.E. Oils. These are balanced to give much greater resistance to deposits, longer life even at high temperatures, superior wear protection and rust prevention.

These new oils will meet the over-all requirements of your hydraulic and circulating systems *better than any other product.*

★ ★ ★

For further information on how new D.T.E. Oils can improve your production and cut costs, fill out the form below.

SOCONY MOBIL
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First Step in Cutting Costs

SOCONY MOBIL OIL COMPANY, INC., and Affiliates:
MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION

* I would like to know more about your new balanced D.T.E. Oils

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Company_____

Street_____ Zone____ State____

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SEND TO: Socony Mobil Oil Company, Inc.
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New York 4, New York

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...a pint, for a steam iron
...or 2,000 gallons per minute, for steam boilers
with Nalcite® (DOWEX*) ION EXCHANGE RESINS
From the small jobs of providing pure water for home steam irons to the big ones of producing silica-free deionized water at 2,000 gallons per minute for large steam generators, Nalcite Cation and Anion Exchange Resins perform with a dependability and efficiency that command confidence throughout the industry.
Facts on Nalcite HCR Cation Exchange and Nalcite SAR and Nalcite SBR Anion Exchange Resins are yours for the asking. Write today for bulletins 57, 58, and 60.
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Nalco® PRODUCTS
When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.

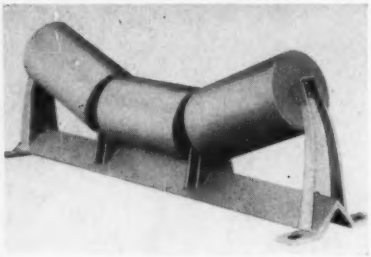
More EQUIPMENT NEWS

Begins on page 162

the control. It can be supplied with thermostats of any temperature setting up to 550 F.

The detector is installed by threading it into a ⅜ in. tap in the housing of various types of bearings that need to be protected. The complete control is 1 13/16-in. long, ⅜-in. diameter and weighs .065 lb. One electrical contact is grounded to the metal housing of the control; the other is a copper lead with teflon glass fibre insulation. Full information available on request to the manufacturer, dept PR 56.

Vapor Heating Corporation, 80 E Jackson St, Chicago 4, Ill.



Belt conveyor idler

422 • Ball-bearing belt conveyor idlers are available in both a greasable type with a "one shot" lubrication system serving all three rolls at once, and a factory-sealed type that require no greasing.

Basically, the idler rolls consist of a smooth, uniformly thick outer shell plus a heavy-wall steel center tube. These tubes are brazed to dish-shaped steel heads, forming a moisture-tight integral unit.

By positioning bearings close to shaft supports, overhang is kept to a minimum. Slotted mounting holes permit positioning of idler to compensate for support structure variations and allow for training of the belt.

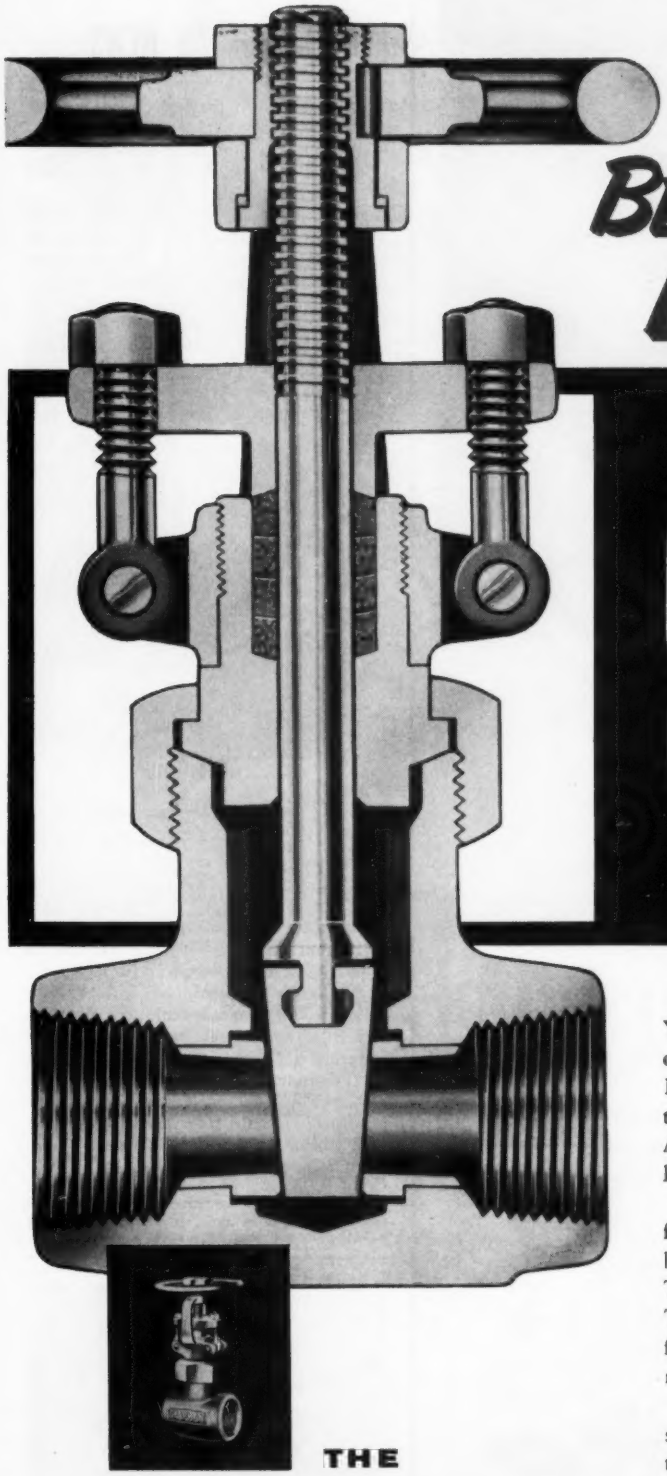
Available for seven belt widths from 14 to 36 in.. Further data in folder 2516, available from manufacturer, dept PR.

Link-Belt Co, 307 N Michigan Ave, Chicago 1, Ill.

For more details on these items, use post cards p 171. Identify your request with item number.

Directional fluorescent lamp

420 • New type fluorescent lamp with an internal reflector surface is said to result in 70% more downward light. An important application of the lamp is in installations where dust or dirt are present. Improvements in lamp lumen-hours are obtained because the lamp is relatively unaffected by deposits of dust and dirt on



DOES A BETTER JOB AT LOWER COST

CHAPMAN LIST

960

SMALL FORGED STEEL GATE VALVE

You'll find Chapman List 960 specified and used on more jobs than any other valve of its kind. It has the range . . . the construction . . . the tightness . . . and smooth operation you need. And it keeps your maintenance down to a new low even under severe working conditions.

There's no seizing or galling. Wedge gate faces are super tough . . . hardened to 800 Brinell by Chapman's exclusive Malcomizing process. There are no full-pressure repacking difficulties. Taper shouldered stem seats snugly in bonnet forging. Stem-and-gate connections are now 50% stronger than ever before.

With its easily replaceable, hardened stainless steel seat rings, Chapman List 960 is the valve that keeps its mind on the job in multiple applications. Sizes from ¼" to 2" . . . in many different alloys. Rising stem with yoke or rising stem with inside screw. Pressures from 380 psi at 1000° F to 2000 psi at 100° F. If higher, get Chapman List 990.

Full information is in our Catalog 10. Get it. Read it. See for yourself why Chapman List 960 is known more and more every day as the valve man's valve. Write for it now.

THE

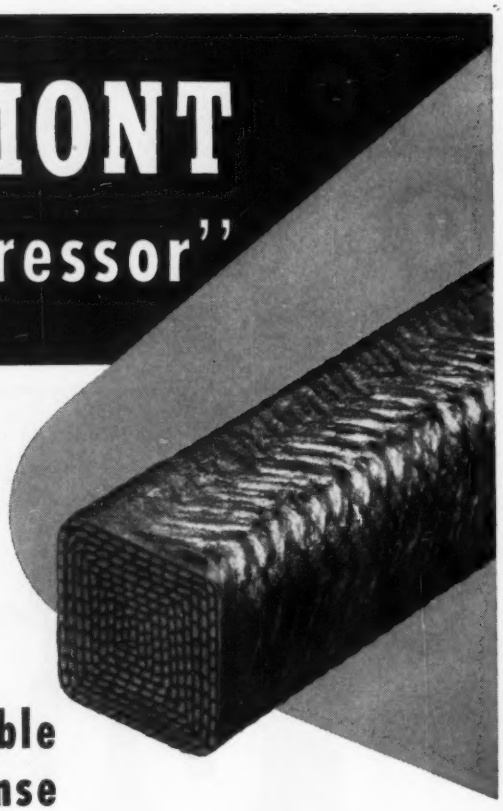
CHAPMAN

VALVE MFG. COMPANY

INDIAN ORCHARD

MASSACHUSETTS

BELMONT "Compressor"



stays flexible under intense dry heat

Here is an Air Compressor rod packing designed to thrive on gruelling service.

Belmont "Compressor" No. 760 asbestos packing is lubricated strand by strand, braid by braid, layer by layer to retain its flexibility and good sealing qualities for life—while protecting compressor rods from premature wear.

Another leader in the Belmont Line of "Custom-made for the Service" packings.

Use it for longer life, fewer maintenance jobs.

Ask your U. S. Gasket—Belmont Packing Distributor or write for catalog.

ask your U S BELMONT Distributor

The Belmont Packing & Rubber Co.
Butler & Sepviva Streets
Philadelphia 37, Pennsylvania

U.S. GASKET • BELMONT PACKING

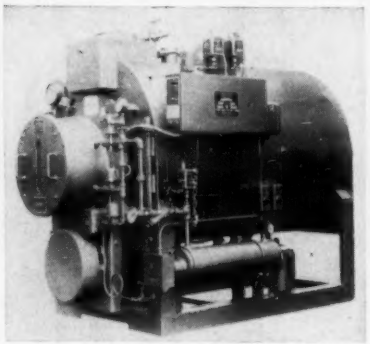
More EQUIPMENT NEWS

Begins on page 162

the top surface of the lamp, manufacturer states. The lamp may be mounted bare without external reflectors.

Indirect lighting effects may be obtained by pointing the lamps toward the ceiling —or the lamps may be turned in various directions to obtain desired lighting effects. An internal reflector coating, covering more than half of the lamp's circumference, provides for a light aperture of less than half of the lamp. Initially, the units are available in the four and eight foot single-pin types.

Sylvania Electric Products Inc, 1740 Broadway, New York 19, N. Y.



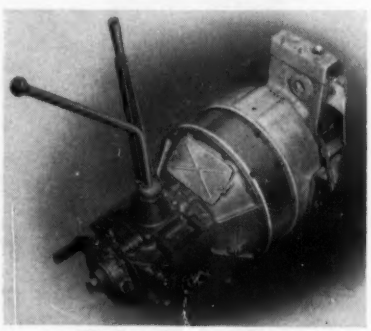
Packaged boiler unit

424 • Unit handles requirements to 50 hp, yet is small in size and meets conditions where space is limited. Boiler measures 7-ft 2-in. long, 3-ft 4-in. wide, 5-ft 2-in. high. Clearance of less than 4-ft from both front and rear doors is all that is required for tube removal.

The boiler is equipped with burner, boiler trim, automatic controls, fiberglas insulation and metal jacket. It can be furnished to burn light oil, No. 5 oil or gas. Combination units that burn either gas or No. 5 oil or lighter can also be furnished. Details from manufacturer.

Boiler Engineering & Supply Co, Inc, Phoenixville, Pa.

For more details on these items, use post cards p 171. Identify your request with item number.



Hydraulic coupling

423 • Overload protection, high power factor and smooth positive acceleration are claimed features of this hydraulic coupling. It is designed to transmit horsepower and

years ahead!

A VERTICAL SPLIT CASE PUMP

6 STAR FEATURES

B & G SERIES 1510

TYPE B CENTRIFUGAL PUMP

. . . with balanced loading of impeller and bearings . . . handles loads far in excess of those produced by any pump and motor combination! Easily serviced without breaking pipe connections!

1. **Leak-proof Mechanical Seal.** Features the exclusive, harder-than-glass B & G "Remite" insert. This Seal construction has enabled nearly two million B & G Pumps to make an amazing record for failure-proof performance.

2. **Balanced Impeller.** All pump impellers are statically balanced and hydraulically balanced where required. Balancing chamber and pressure relief holes reduce thrust to a minimum.

3. **Solid-type Volute with Support Foot.** Can be left in pipe line when servicing pump —rugged construction absorbs piping strains.

4. **Removable Bearing Frame.** Complete bearing frame, including seal and impeller, can be removed without disturbing piping or motor leads. The bearing frame is replaceable and interchangeable on all sizes.

5. **Anti-Friction Roller Bearings.** Timken Bearings handle thrust and radial loads for smoother, quieter, more efficient operation.

6. **Oil Lubrication.** No messy, undependable grease cups—circulating oil lubrication assures positive protection to bearings. Oil level indicator permits visual check.

STOCK PUMPS!

Selected sizes of B & G Series 1522 and 1531 Centrifugal Pumps are stocked at the factory for immediate shipment. Capacities to 225 GPM, heads to 140 ft. Send for Price and Selection Catalog.

BELL & GOSSETT
COMPANY
Dept. EH-36, Morton Grove, Ill.
Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto, Canada

If this Housing ever Breaks or Distorts we will replace it Free.

Even *without* this famous guarantee

Genuine

RIDGID

would still be the

World's Most Popular Pipe Wrench

Every RIDGID Pipe Tool TESTED individually before shipment
If this Housing ever Breaks or Distorts we will replace it Free
RIDGID
14

...and no wonder— millions of users know it *out-performs, out-lasts* all others!

It's the "RIDGID" name that guarantees you everything you want in a pipe wrench — instant bite on the pipe, instant let-go — it can't lock, assured by patented hookjaw suspension . . . handy pipe scale, easy-spin adjusting nut, comfort-grip I-beam handle . . . and every one factory-tested before shipment!

"Threaded Pipe — *It's Tight — It's Best — Costs Less*"

Always most for your money . . . your Supply House has them!

RIDGID Work-Saver Pipe Tools

The Ridge Tool Company • Elyria, Ohio, U.S.A.

More EQUIPMENT NEWS

Begins on page 162

torque through a fluid, thereby improving performance characteristics and cushioning both engine and equipment from shocks of sudden load applications.

Unit is suited for use on compressors, conveyors, blowers, cranes, crushers, pumps and other industrial applications.

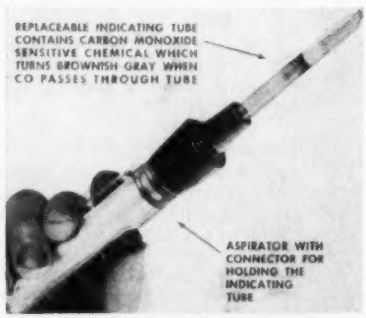
Continental Motors Corp, 205 Market St, Muskegon, Mich.

TV remote-control units

425 • These units make possible complete control of all camera operations for industrial and institutional TV applications. The equipment is highly suitable for surveillance work and remote monitoring of operations. Full 360-deg camera viewing and 90-deg tilt are obtainable with both indoor and outdoor mountings. Two restyled camera control units, portable and wall-mounted, are available with plug-in control panels that may be removed to provide remote operation of beam, focus, target, blanking and gain.

General Precision Laboratory Inc, Pleasantville, N. Y.

For more details on these items, use post cards p 171. Identify your request with item number.

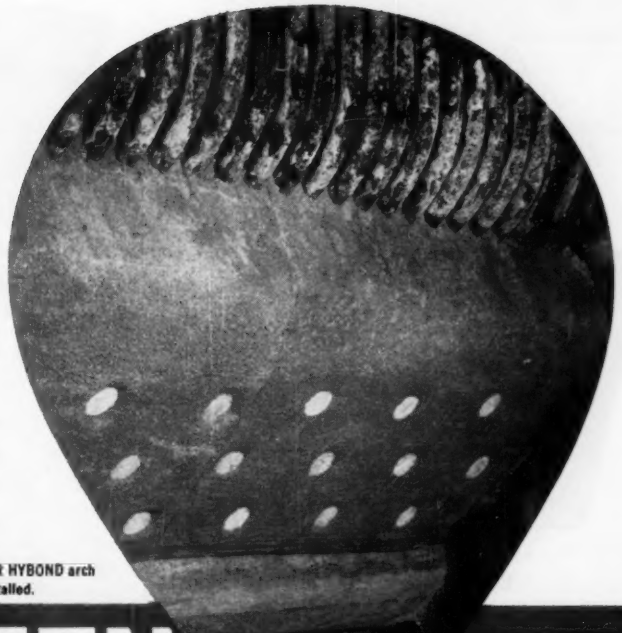

REPLACEABLE INDICATING TUBE CONTAINS CARBON MONOXIDE SENSITIVE CHEMICAL WHICH TURNS BROWNISH GRAY WHEN CO PASSES THROUGH TUBE
ASPIRATOR WITH CONNECTOR FOR HOLDING THE INDICATING TUBE

Carbon monoxide detector

417 • Pencil-size detector shows at a glance if, in air being tested, carbon monoxide is present in any concentration that is dangerous for either occasional, short-time or long exposure.

Tester comprises a replaceable indicating

A SUPER HYBOND arch was installed in a B & W coal fired boiler, with a chain grate stoker, in an Indiana Municipal light plant. The boiler is rated at 125,000 lbs. per hour, and operates at about 200% of rating. Prior to the use of SUPER HYBOND it was necessary to replace the arch in this boiler every 9 months. The SUPER HYBOND arch was not replaced for 3½ years and even then, as shown by the photos, could have given additional service.



SUPER HYBOND arch as installed.

A.P. GREEN

Super Hybond Suspended Arch Gives More Than 4 Times the Service of Previously Used Refractory Arch

SUPER HYBOND arch after 3½ years' service.

SPECIFY A. P. GREEN PLASTIC FIREBRICK LININGS for longer life... lower maintenance costs

For over 30 years, A. P. Green plastic firebrick, made from highest quality Missouri fire clays, has been proved in service. Four grades of plastic to meet varying refractory needs.

warehouse stocks for prompt shipment

Look in the classified section of your telephone directory or write direct for the name of the A. P. Green distributor in your locality. He has complete stocks and can make prompt delivery.

A. P. Green **REFRACTORY PRODUCTS**

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

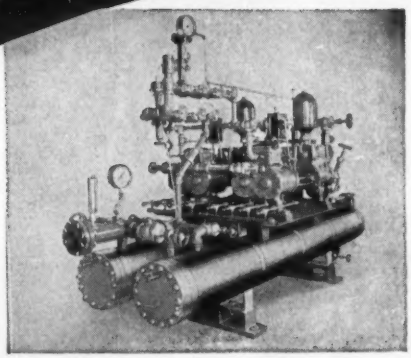
PLANTS: Mexico, Mo. • Woodbridge N. J. • Sulphur Springs, Texas
IN CANADA:
A. P. Green Fire Brick Company, Ltd., Toronto 15, Ontario

Enco Automatic
OIL PUMPING
AND HEATING SYSTEM

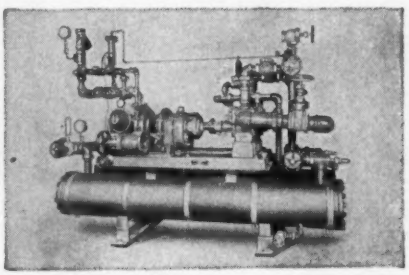
Completely Coordinated

Every detail part of an Enco Automatic Oil-Heating-and-Pumping Unit System is designed, assembled, checked and tested to make sure that it functions as an element of a completely coordinated unit. The sizes of pipes, fittings, valves and other elements are correctly proportioned for the efficient, dependable operation of the unit as a whole. All hand controls are visible and within reach of the operator for quick starting, stopping or cross-over reconnections between duplicate heaters and pumps. Adjustments and cleaning are similarly simplified.

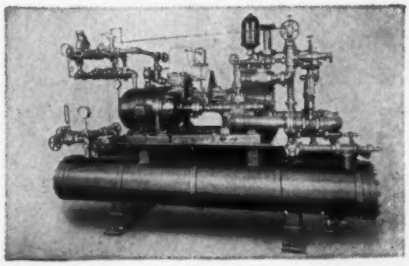
Single or duplicate heaters and electric or steam-driven pumps are used. Interconnected duplicate units give full capacity with either pump or either heater. Capacities range from 100 to 5000 G. P. H. of heavy bunker oil.



Two Horizontal Duplex Piston Type Steam Pumps and two fuel oil heaters—capacity 15 G. P. M. at 250 lb. pressure with either pump or heater.



One Turbine and One Motor Driven Pump and two fuel oil heaters. Capacity 30 G. P. M. at 150 lb. pressure with either pump or heater.



One Horizontal Duplex Piston Type Steam Pump and one Motor Driven Pump and two fuel oil heaters. Capacity 20 G. P. M. at 300 lb. pressure with either pump or heater.

BULLETINS ON REQUEST

OB-37 On oil burning, pumping and heating equipment.

OB-38 Instruction book on care and operation of oil-burner installations.

THE ENGINEER COMPANY
75 WEST STREET Enco NEW YORK 6, N.Y.

More EQUIPMENT NEWS

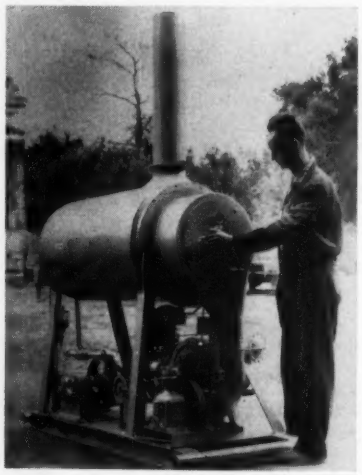
Begins on page 162

tube and aspirator pump with connector for holding the tube during test. The glass indicating tube contains a yellow carbon monoxide sensitive chemical that turns brownish-gray when carbon monoxide passes through the tube.

Sealed tube ends are broken off when tube is inserted into pump connector. Air is then drawn through tube by depressing button in center of pump barrel. When button has returned to its original position (about 6 sec) the indicating tube is examined. If chemical shows brownish-gray stain, CO concentration exceeds limit allowable for short time exposure—area should be cleared immediately. If chemical shows no stain a second pump stroke is taken. Appearance of stain after this stroke indicates CO concentration begins to constitute a danger to health—room should be occupied for only short durations. No appearance of stain after the second pump stroke indicates that there is no hazardous CO concentration in the air being tested.

Bacharach Industrial Instrument Company, 7301 Penn Avenue, Pittsburgh 8, Pa.

For more details on these items, use post cards p 171. Identify your request with item number.



Portable hot-oil heater

416 • Unit is designed to heat 70 barrels of crude oil per hour, to speed up the process of treating oil in field-storage tanks, to clean paraffin out of flow lines and to heat oil for pumping under high pressure. It is also used to blend heavy crudes with lighter oils and as a preheater for heavy crude oil.

An outstanding feature, according to manufacturer, is unit's ability to burn most crude-oil fuel. This is accomplished by air-atomizing the crude-oil forced through a patented fuel nozzle. Unit is also being made to burn natural gas, propane and regular fuel oils.

The heater puts out 2,500,000 Btu per hr when full on. Hot gasses from the fire wipe over and around a specially designed steel tube coil and transfer the heat to the

Traveling Stocking and Reclaiming Coal Handling Tower

OF WELDED DESIGN

a Mead-Morrison development

All connections in the main structure of this tower, both shop and field, are welded. The cantilevers employ riveted connections and are fastened to the main structure by means of rivets.

This modern design is typical of Mead-Morrison pioneering in developing stronger and more economical material-handling equipment. Write for complete information on Mead-Morrison Towers and Bridges for coal, ore and other materials.

Coal is brought to the plant of a large West Virginia steel mill in cars which dump into a digging pit alongside the Mead-Morrison tower. Unloading of the cars is aided by a car shakeout suspended from the side of the tower.

The tower digs coal from the trough and delivers it to the near-side stocking pile at the rated capacity of 915 tons per hour, and to the far-side stocking pile at the rated capacity of 610 tons per hour.

The tower also reclaims coal from the storage piles to the receiving hopper in the tower at the rated capacity of 765 tons per hour from either pile.

Included in the Mead-Morrison equipment are a 6½ ton lightweight grab bucket and automatic rail clamps to protect the structure in a high wind. Adjustable voltage is used for the hoist, close and trolley motions, and constant voltage for the propelling motors.

MEAD-MORRISON

Division of McKIERNAN-TERRY CORPORATION

MANUFACTURING ENGINEERS

Harrison, New Jersey • Plants at Harrison, N. J. and Dover, N. J.

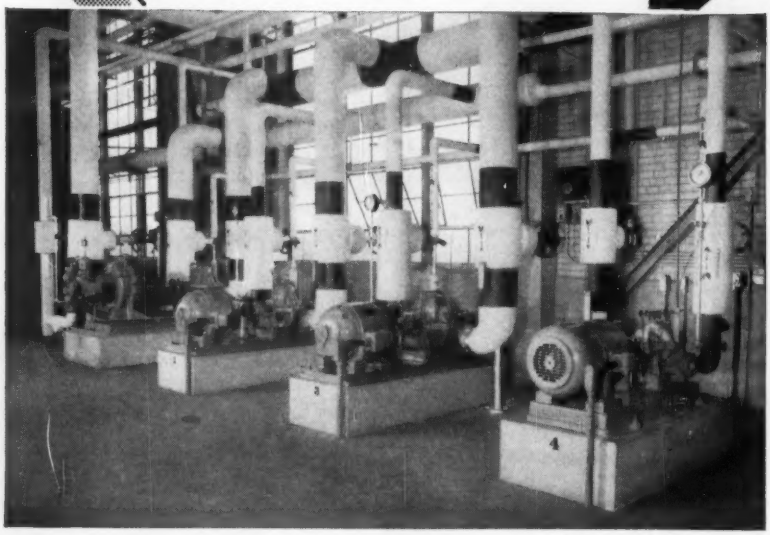
dependable

. . . or else!

Boiler Feed Pumps, like these four Warren Pumps shown at the new, ultra-modern North Grafton, Massachusetts, Heavy Press Forging plant of

WYMAN GORDON COMPANY

must always be available for round-the-clock operation—if and when necessary.



Photograph, courtesy Wyman Gordon Company. Other Warren Pumps in this plant include Condensate and Fuel Oil Transfer.

These experience-rated Warren Pumps, and thousands of others in the power plants of important and vital industries, are built with substantial plus factors as to dependability, low maintenance and economy.

BOILER FEED, CONDENSATE, FUEL OIL BURNER AND OIL TRANSFER SERVICE . . . there are types and sizes of Warren Pumps that will meet your requirements and live up to their reputation for dependability, minimum maintenance, economical operation and long life.

WARREN QUIMBY PUMPS

P-33

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.

Warren, Massachusetts

More EQUIPMENT NEWS

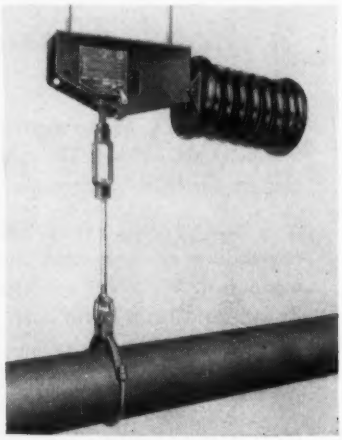
Begins on page 162

oil as it is pumped through the coil. Outlet oil temperature may be regulated between 200 and 300 degrees.

Texsteam Corp, 320 Hughes St, P.O. Box 9127, Houston 11, Texas

We pulled a boner . . .

how else can we explain a pipe supporting a pipe hanger . . . as photo on p 186 February POWER would indicate. Of course it's our blooper. Correct position of photo with descriptive copy appears below:

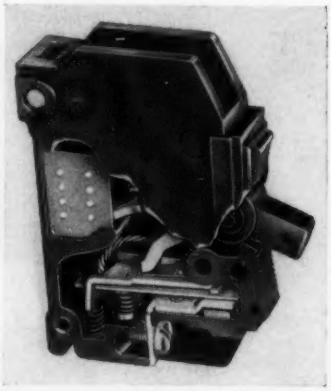


Constant support hangers

227 • These hangers are used to provide constant support for hot piping in power and chemical plants and in nuclear-atomic operations. They permit expansion and contraction of piping systems, through heating and cooling cycles, without developing dangerous stresses. Nine frame structures are available. Load capacities are from 31 to 32,267 lb. Details from manufacturer.

Grinnell Co, Inc, 260 W Exchange St, Providence, R. I.

For more details on these items, use post cards p 171. Identify your request with item number.



Circuit breaker

426 • Ambient compensated circuit breaker is designed for 120-v ac lighting and power distribution panels. The unit,

Lunkenheimer Announces

ANOTHER GREAT NEW LQ600 VALVE

200 Lb. S.P.! 400 Lb. W.O.G.!

Lunkenheimer's famous LQ600, the Bronze Globe Valve that set a new high standard of performance on 150 lb. service, is now available for 200 lb. S.P., 400 lb. W.O.G. applications. The new line features the same long-wearing flat seats and discs made of Brinalloy®, plus a body and bonnet of Lunkenheimer's amazingly strong S-1 Bronze for higher-pressure service. Install this great new LQ600 Valve on your 200-lb. pressure lines—including all your toughest services—and compare its performance with other valves. It's built to eliminate maintenance costs because there is no replacement of seats and discs—they are patented Brinalloy, brazed in to stay, harder all the way through and more resistant to wear and corrosion than 500 Brinell Stainless Steel and far exceeding the wear resistance of 1000 Brinell case-hardened Stainless Steel.

LUNKENHEIMER QUALITY

Now there are *TWO* LQ 600 Valve Lines

The original LQ600 Valve for 150 lb. S.P., 300 lb. W.O.G. service has received the fastest acceptance of any valve introduced in years. Thousands of these valves are in service—some as long as five years—without a single reported case of failure or leakage.

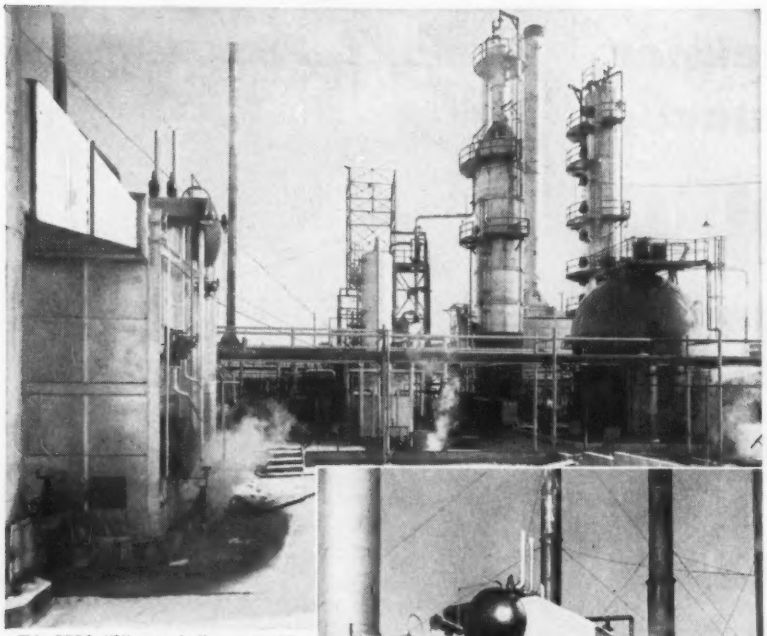
FOR COMPLETE INFORMATION WRITE.... The Lunkenheimer Company, Box 360, Cincinnati 14, Ohio, or get in touch with your Lunkenheimer Distributor.

BRONZE • IRON • STEEL • PVC

LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

L-256-27



This BROS "S" type boiler at N. W. Refining Co., easily handles steam requirements winter or summer, regardless of ambient temperature.

BROS

"S" TYPE BOILER

Outdoor Installation Provides Dry Steam at 20° Below

Winter, summer, rain or snow this BROS "S" type boiler is providing dry process steam "around the clock" for Northwestern Refining Company, St. Paul Park, Minnesota, refiners of high octane gasolines and other top quality petroleum products.

Designed for Expansion

The boiler is designed for a pressure of 250 psig; at present it supplies the refinery's steam requirements for process and heating, at 125 psig. It is installed on a special steel base so that if the needs of the refinery change, the boiler can be moved in one piece to any desired location.

Outdoor Installation

Built completely within an insulated steel case, the boiler is installed outdoors, and maintains the load as easily at 20° below zero as it does at 100° above. It provides dry steam for heating buildings, oil tanks, tank cars, etc. With a capacity of 30,000 lbs. of steam per hour and 50° superheat, the flexible steam requirements for a refinery are easily accommodated.

Gas-Oil Combination

The boiler is fired by 4 combination gas-oil burners. It operates with natural draft using a 150 ft. stack. It is currently being fired with fuel gas from Northwestern's catalytic cracking unit.

BROS Boilers Meet the Need

BROS "S" type boilers provide *high efficiency, low maintenance costs, minimum space requirements and simplified installation.* Capacities range from 10,800 to 50,000 lbs. per hr. with design pressures up to 600 psi.

Write today for your free copy of the new "S" type boiler brochure. Contains complete specifications and drawings.

WM. BROS BOILER & MFG. CO.

POWER DIVISION / 1057 Tenth Avenue S. E. Minneapolis 14, Minnesota

Designers and Manufacturers of Watertube Boilers, 2-3-4 Drum and Packaged Designs, Auxiliary Equipment, and a full line of Industrial Stokers.

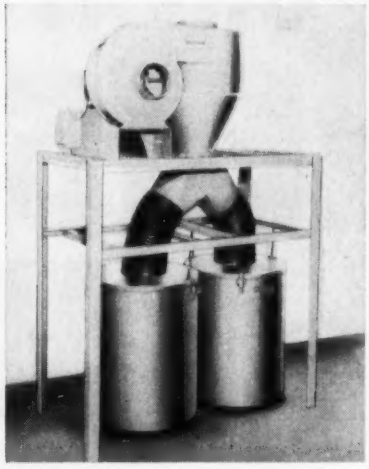
More EQUIPMENT NEWS

Begins on page 162

which acts with increased speed to protect circuit wiring, eliminates tripping due to ambients varying between 30 and 140 F.

These features result from a "ten times rating" magnetic trip for short circuit protection—the 15-amp unit will trip magnetically at 150 amp. Breakers are supplied in full range of ratings: 15, 20, 30, 40 and 50 amp. Details in catalog 1-150.

Federal Pacific Electric Co,
50 Paris St, Newark 1, N. J.



Dust collecting unit

418 • This collector is specifically designed for outside air exhaust where use of recirculating air collectors is not practicable or is prohibited by local regulations. It is also adaptable for installations where toxic fumes, obnoxious odors or smoke, as well as dust, accompany the operation for which the collector is used. The unit does not remove the fume or odor from the air but merely exhausts it out of doors through a pipe connected to the outlet collar. Designated *Dustkop 11NW50,* unit has an increased capacity up to 64 gal. and should be used where dust, shavings, chips or other collected material runs to greater volumes.

Unloading maintenance is simplified by virtue of a wire reinforced neoprene flexible hose that connects to the rubber castered storage cans individually, and to the collector by a diverting "Y." This diverts the flow of dust to one can while the other is removed for dumping.

Aget Manufacturing Co.
Adrian, Mich.

For more details on these items, use post cards p 171. Identify your request with item number.

50-kvar power capacitors

419 • Company has changed dimensions of their 50-kvar power capacitors to make them fit racks designed for 25-kvar units. New capacitors have same base dimensions as the 25-kvar model but are 11 in. taller, 32 in. to top of bushings. Weight is about 110 lb. Available in 5 and 8.7-kv class.

General Electric Co,
Schenectady 5, N. Y.

Boiler feed water from this?

The grotesque creatures hanging here are simply salt-encrusted canvas-bagged anodes used in metal plating. The solution in which they are partially immersed contains a high percentage of metal salts such as those of copper, nickel, or chromium.

After the metals are plated in this bath, they are thoroughly rinsed, then polished or otherwise treated. Until recently, the rinse water—as much as 20,000 gallons a day in some plants—was discarded, valuable metals and all.

Today, treatment of the rinse water with AMBERLITE® Monobed ion exchange resins permits economical recovery of the metals *and of the water*. This water is of the same high quality as deionized water from standard water supplies—and can be used even for high pressure boilers.

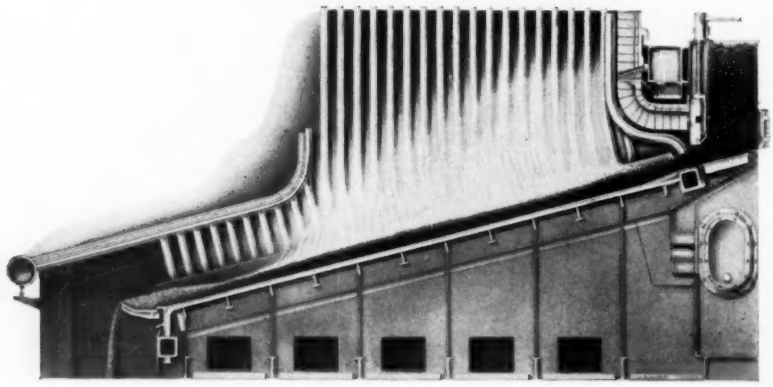
Just think of what deionization with AMBERLITE Monobed resins can do for your water supply. Or, if you prefer the facts before you think about it, ask us for your free copy of "If You Use Water," 24 pages of detailed information.

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION, PHILADELPHIA 5, PENNSYLVANIA

CHEAP COAL-- *something to get steamed up about with an*

AE VIBRA-GRATE



WHAT COAL best fits your plant pocketbook? High or low fusion? West Virginia, Illinois, or Western Kentucky? American Engineering's unique Vibra-Grate Stoker burns them all efficiently... with complete freedom from clinkers ...with low excess air and low carbon loss.

Completely water-cooled, the Vibra-Grate burns low grade fuels without smoke at either low or high ratings... and no dust collectors are necessary. Stack emission will comply with all local ordinances.

Herewith is the analysis of three coals recently burned successfully on a Vibra-Grate of 45,000 lbs. steam per hour capacity. These results are typical of others obtained with a wide variety of coals on a Vibra-Grate at the Columbus, Ohio Laboratory of Bituminous Coal Research, Inc.

PROPERTIES	ILLINOIS	WESTERN KY.	WEST VA.
Moisture	9.0	5.7	1.55
Ash	7.73	8.1	5.65
Volatile	35.85	38.6	31.44
Fixed Carbon	47.42	47.6	61.36
Sulphur	1.18	3.3	0.657
B.T.U.	12,121	12,500	13,560
Ash Softening Temp.	2120°	2050°	2700°

IN SERVICE NEARLY A DECADE

Vibra-Grate Stokers of present design have been in service abroad since 1947, and earlier versions, since 1939. If you plan to install a new boiler or restoker an old one with capacities from 20,000 to 150,000 lbs. steam per hour, write for full facts about Vibra-Grate's amazing combination of advantages.

STOKER INCINERATOR GRATES, TOO

A properly engineered stoker incinerator is today's best answer for refuse disposal... and AE's know-how in stoker design is your best assurance of all-around incinerator efficiency. Your inquiries are invited.

AMERICAN ENGINEERING COMPANY

DEPT. S-100, WHEATSHEAF LANE & SEPVIVA STREET, PHILADELPHIA 37, PA.

Canadian Subsidiaries: Affiliated Engineering Corporations, Ltd., Montreal, P. Q.... Bawden Industries Ltd., Toronto, Ont.

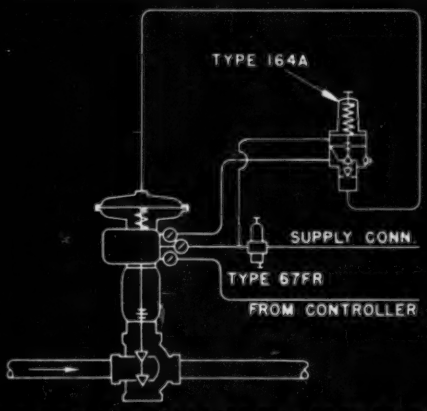
AE products are: Taylor, Perfect Spread and Vibra-Grate Stokers, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers, Marine Deck Auxiliaries.

FISHER® SERIES 164

For "Gadgeteering" Control

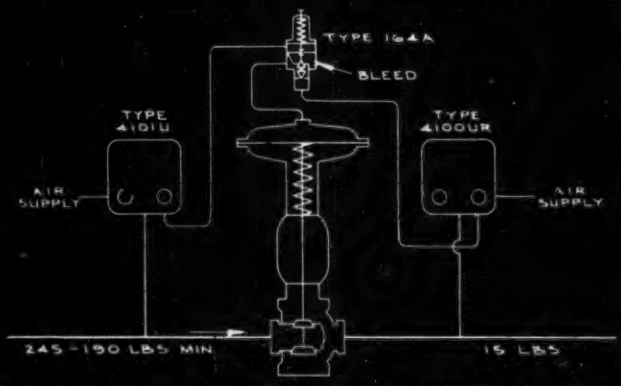
SUCH AS

TWO-WAY ACTION for SAFETY LOCK-UP

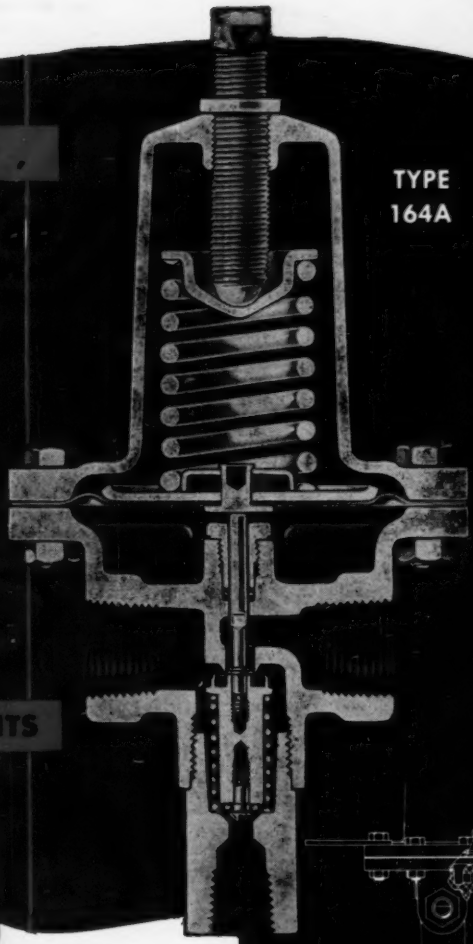


Lock-up system using Type 164A to close air circuit to diaphragm of main valve in case of plant air failure. Main valve will be held in position at time of supply pressure failure.

or THREE-WAY ACTION for SWITCH AIR CIRCUITS



Pressure reduction normally handled by 4100UR Wizard. If inlet pressure to main valve falls below a predetermined amount Type 4101U snap-acting Wizard bleeds pressure off Type 164A switching valve causing 3-way valve to change position so as to close control line pressure and bleed main valve diaphragm pressure to atmosphere. Main valve will stay closed until inlet pressure is restored to desired amount.



- SMALL
- COMPACT
- SELF CONTAINED

Side view of Type 164 Showing ¼" Control Line Connection. Control Chamber is separate from body chamber.

SIZES ¼" or ½"

CONTROL SPRING RANGES PSI	PRESSURE CHANGE ON DIAPHRAGM FOR FULL VALVE STROKE, PSI
3 to 15	2
5 to 20	2½
5 to 35	4
30 to 60	5¾

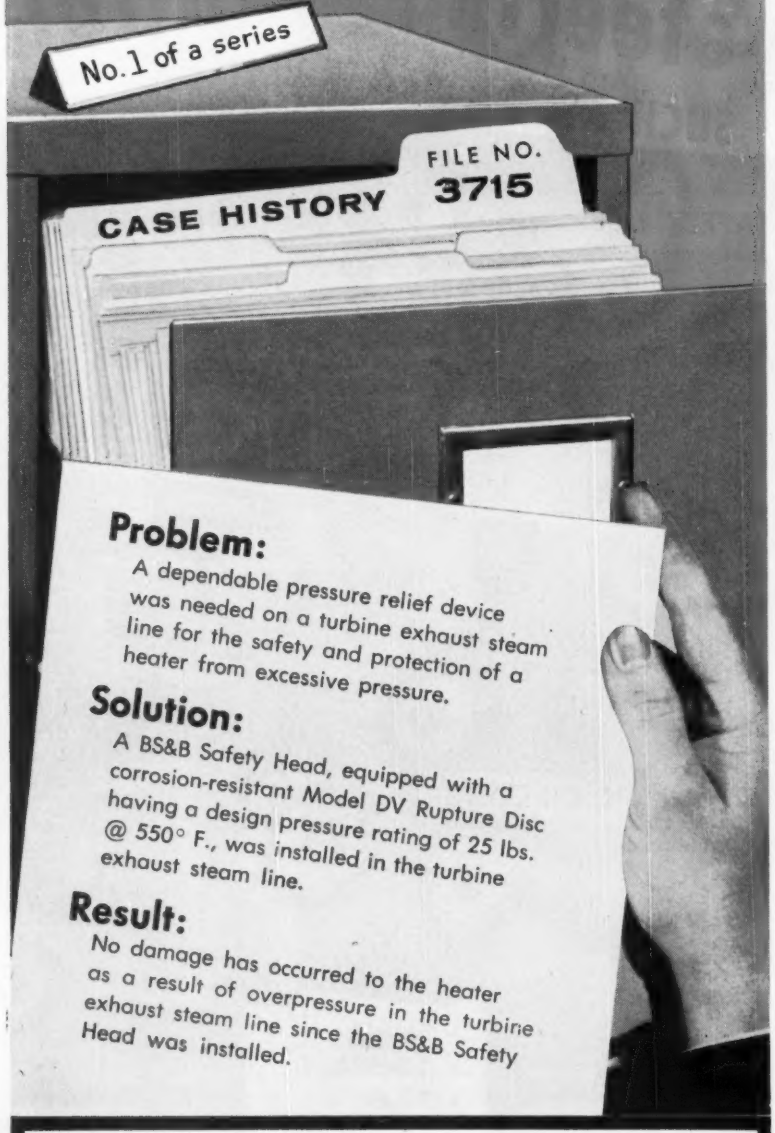
MATERIALS

Zinc die cast body and spring case, composition diaphragm and valve disc.

ISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA
CANADIAN PLANT: WOODSTOCK, ONTARIO
WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

BS&B Safety Heads SOLVED THE PROBLEM!

No. 1 of a series



Problem:

A dependable pressure relief device was needed on a turbine exhaust steam line for the safety and protection of a heater from excessive pressure.

Solution:

A BS&B Safety Head, equipped with a corrosion-resistant Model DV Rupture Disc having a design pressure rating of 25 lbs. @ 550° F., was installed in the turbine exhaust steam line.

Result:

No damage has occurred to the heater as a result of overpressure in the turbine exhaust steam line since the BS&B Safety Head was installed.

OVER 60 YEARS RELIABILITY BS&B ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

Have you considered what BS&B Safety Heads can do to improve the safety of **your** pressurized equipment? Complete information on the many possible applications of BS&B Safety Heads will be sent on request.

THE "CIRCUIT-BREAKER" of Pressured Systems

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-Q4

7500 East 12th Street Kansas City 26, Missouri

MARMADUKE

Continued from page 150

mail contract. Up to 95 rpm, they worked OK. But forcing them at top speed for days gave trouble. We had to pull one of her 22-inch pistons in almost every port. And there were 16 of them. Some of her piston rings would be burned so badly that we usually had to replace all five in the set.

"That was a tough trip. Everything seemed to go wrong. In Valparaiso, Chile, we found a cracked main-engine liner. Those gunmetal ported liners cost a few thousand dollars in those days. We pulled the liner, but every time we lowered her into place the rubber O-ring seals in the bottom V grooves would shear. Then when we turned on the cooling water, salt water would pour into the crankcase. We finally finished the job, but it took 49 hours of working around the clock with chain falls and button sets.

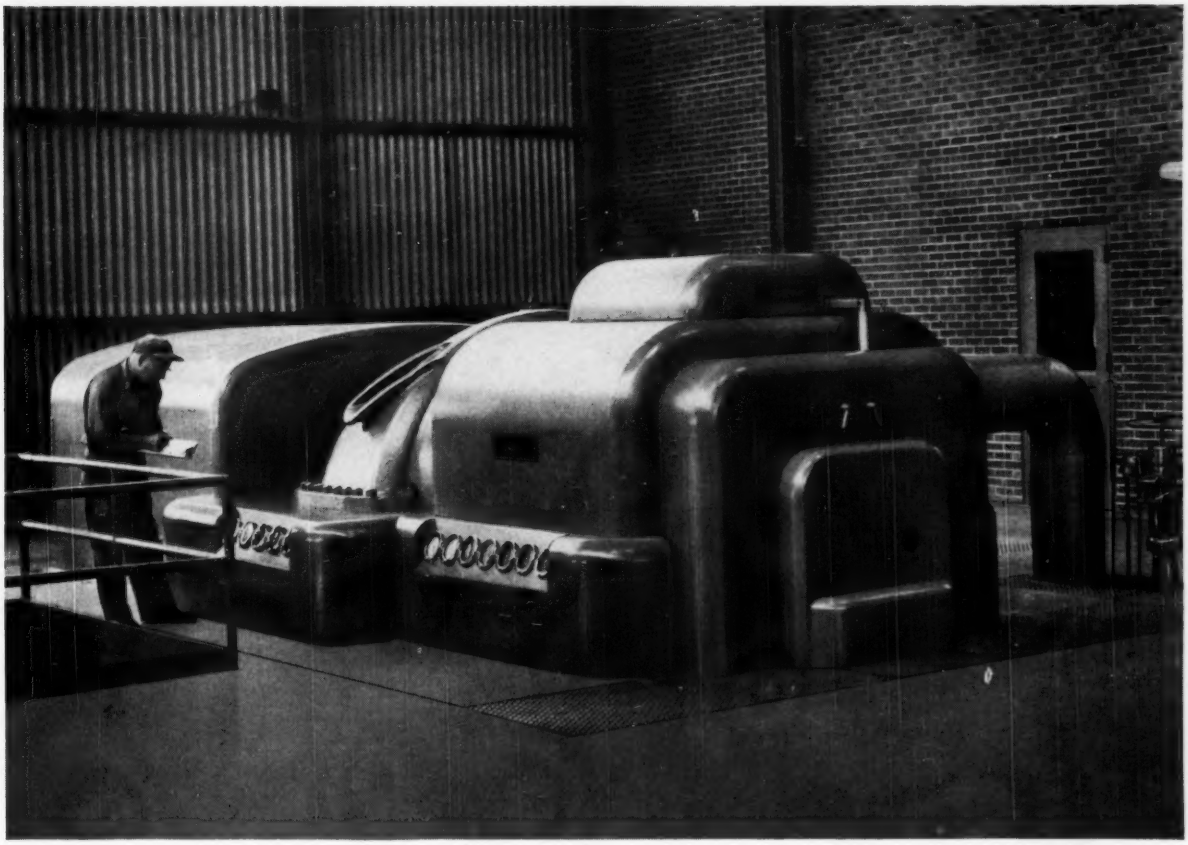
"Then getting into Callao, Peru, one Sunday morning, one of the auxiliary engines started sputtering. She stopped before the watch engineer could get to her. Next, No. 2 auxiliary started acting up and she failed. When I got below, the plant was dead, including the main engines.

"We opened the drain cocks on the engine's fuel pumps and found only water. Checking the day tank, I found it filled mostly with water. What happened was that the centrifuge oiler got his valves fouled up and sent water to the day tank on starting up and fuel oil to the bilges. By the time we drained the system and got squared away, it was 10 am and the passengers hadn't had breakfast. There would be hell to pay in New York.

"Leaving Talara, Peru, the steering-engine telemotor blew a gasket and we lost a lot of telemotor fluid. Another few hours were lost straightening her out. On that trip, I spent more time below than up topside.

"Shortly after leaving Buenaventura, Colombia, just off the equator, the sea suction to the starboard auxiliary diesels got plugged. Before anyone knew it, engines started heating. We had to shut down, close the sea suction valve and blow out the suction with steam. Then the engines had to be

SPECIAL



Industrial and municipal turbine generator specialists give priority service up to 15,000 kw.

Worthington specialists in designing and manufacturing turbine generators up to 15,000 kw. are changing a lot of established buying ideas. Because they're not involved with building the huge central station turbine generators, Worthington engineers can give A-1 priority to every phase of design and manufacture of industrial and municipal units. They deliver a power package that has been completely tested, and adjustments made, to shorten installation time. They incorporate latest design advances in the turbine and generator, and finish the job with a streamlined heavy steel jacket to blend with the most modern power plant design.

When considering a turbine generator installation up to 15,000 kw., call on specialists in the field. Call your nearest Worthington District Office or write for Bulletin 1960C: Worthington Corporation, A&SP-Turbines, Harrison, N. J.

WORTHINGTON

Want better gate valve service?

Cutaway, showing the simple and unique Darling fully revolving double disc gate valve principle that equalizes disc and seat wear, compensates for valve body distortion and provides prolonged tight closing.

IN *your* service Darling gate valves will offer you many times the customary number of operating cycles before repair or replacement is necessary.

It's the unique Darling *fully revolving double disc parallel seat* principle that does it. Get all the facts and see how you save on down-time, part replacement and maintenance.

Darling offers these gate valves in sizes, types and metals for all kinds of normal and unusual services. Write for details, specifying your service requirements.

DARLING VALVE & MANUFACTURING CO.
Williamsport 8, Pa.

Manufactured in Canada by
Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

MARMADUKE

Continued from page 192

cooled gradually before starting up again.

"That night I turned in about midnight and expected to get my first good night's shut-eye in over a month. We were running at only 95 rpm and the old man had told me we'd make Panama City about 9 am. But at 2 am the 12-to-4 oiler came banging on my door. 'What in hell's wrong now?' I finally asked, coming to life.

" 'Don't know, Chief,' he gulped in broken English. 'Engines—she's get tired, she's slow down, I donno.'

"When I hit the engine-room floor plates in my pajamas, the Second Assistant was running around in circles, checking everything. 'She's Greek to me, Chief,' he wailed, cussing a purple streak. 'All of a sudden both main engines slowed down from 95 to 91 revs. I checked everything, can't find a thing wrong.'

"I didn't answer. Tachometers on both main engines were 4 rpm shy—no question about that. So many things happened on that trip that I was set for anything. I checked the injection-air pressures, lube oil, exhaust temperatures, cooling water, then looked into the cylinder ports. I even checked the fuel, but everything seemed OK. It was easy to get back those revs by opening the fuel throttles, but that wouldn't tell us what had slowed us down.

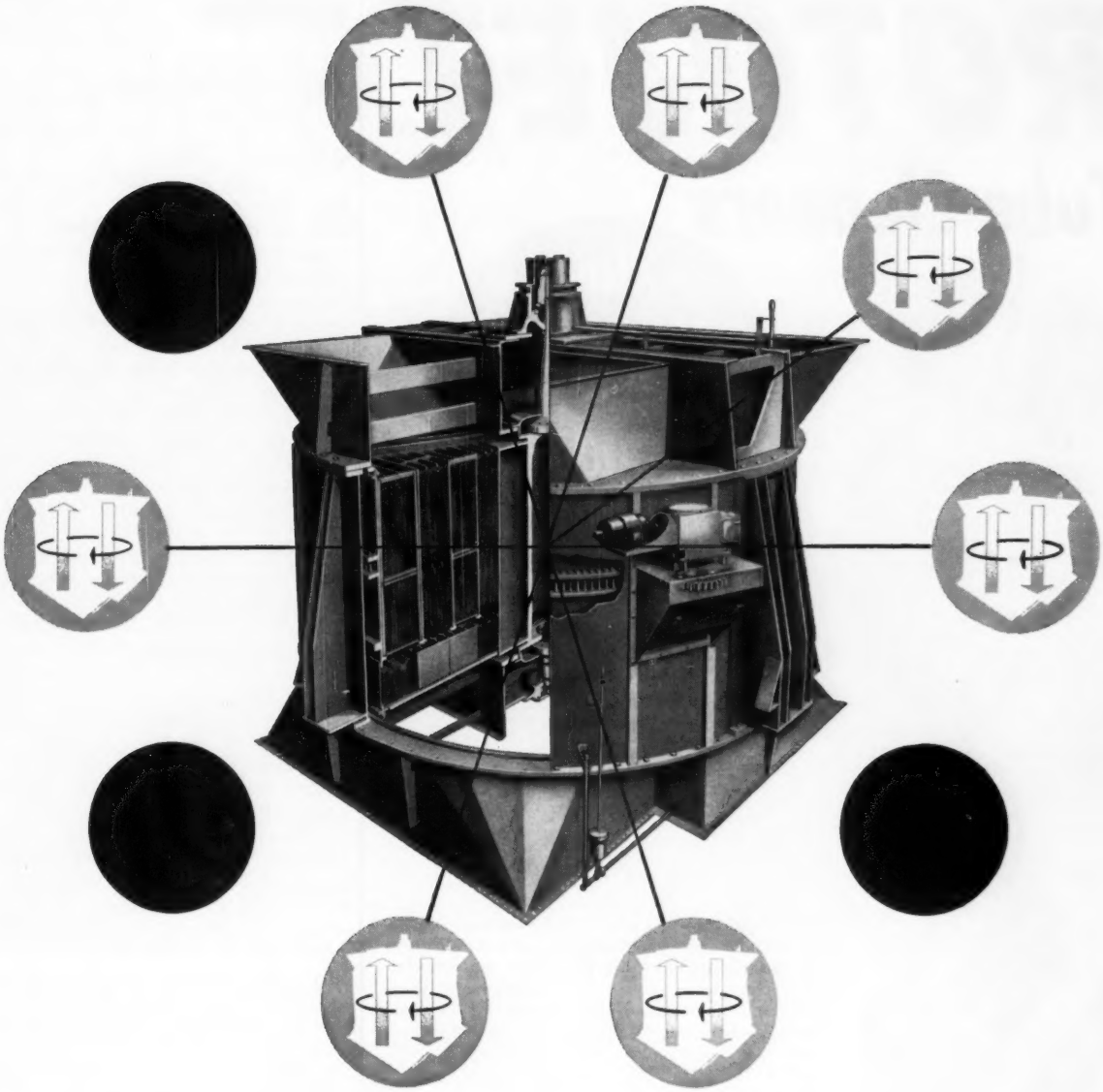
" 'From the way these babies slowed down you'd think we started going up hill all of a sudden,' wailed the Second, breathing down my neck.

" 'Going up hill?' I echoed, almost in a trance. 'We *are* going up hill. Right now we're just off the equator, so we're at about 90 degrees with the earth's surface in a perpendicular position—going straight up.' That crack wasn't funny to the Second, but it gave me a sudden brainstorm. Just then the engine-room telephone rang. The oiler answered, said the Second Mate up on the bridge wanted me.

" 'Say, Chief,' yelled the Second Mate into the phone. 'We seem to have slowed down—is something wrong below'?

" 'Wrong below? Nothing,' I yelled back. 'If anything's wrong, it isn't here—it's up there with you fellows.'

" 'What?' he barked. But I hung up



7 out of 10 *air preheater installations are Ljungstrom®*

Advantages of the Ljungstrom Air Preheater

- Size for size, recovers more heat than any other type.
- Reduces fuel consumption. Permits use of lower-grade fuels. Increases boiler output and reliability.
- Eliminates cold spots . . . keeps corrosion to a minimum.
- Easier, faster to clean and maintain.
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FUEL ECONOMY is the big reason. Size for size, the Ljungstrom recovers more heat than any other type of air preheater. And with every 45-50 F of air preheat you cut your fuel bill 1%.

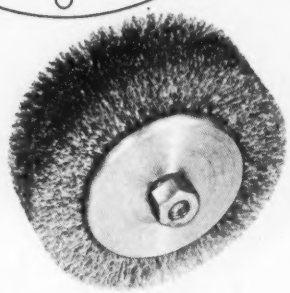
Write now for your copy of our 38-page manual, for handy reference.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

ROTOJET®
Tube Cleaners

Clean tubes and pipes from ½" to 12" I.D. THOROUGHLY QUICKLY

ROTOJET Model 512 Air-driven Motor, universal joint, swing-frame head, and solid brush.



Our large stock of Rotojet air-driven and water-driven tube cleaners, accessories, and repair parts for straight and curved tubes, pipes, and transfer lines is available to meet most requirements without delay. Tube cleaner specialization for 43 years assures satisfactory results from any Rotojet equipment we recommend. Send for Bulletins J-410 and R-105. For quick action wire or phone, HUmboldt 3-0570.

ROTOJET Junior Model S32 Air-driven Motor, universal joint, cone cutter.

ROTOJET Model C-525 Air-driven Motor with swing-frame head and universal joint.

ROTOJET Junior Model C434 Air-driven Motor, flexible coupling, expanding brush.

ROTOJET Model C-526 Air-driven Motor with pivot head and universal joint.

ELLIOTT COMPANY - ROTO DIVISION

Tube Cleaner Specialists Since 1910

153 Sussex Avenue, Newark, N. J.

MARMADUKE

Continued from page 194

and started for the ladderway.

"'Where you going, Chief?' asked the Second Engineer with a dumb look on his face.

"'I'm going up on deck to get back those four revs we lost,' I told him over my shoulder. That stopped him again. Stepping into the alley-way I glanced below. The Second was still scratching his head. I got into my khakis in my room and headed for the deck.

"Up on deck I got to the bow and flashed my light into the water. From there I hot-footed up to the Second Mate. He was walking back and forth on the flying bridge, muttering to himself. Just as I got there, the Captain arrived in his fancy Chinese pajamas.

"'What the rattling hawepipe are those fiddley engineers up to now?' raved the skipper before he saw me, rubbing the sleep from his eyes.

"'Nothing's wrong with the engineers, but plenty's wrong with the deck department,' I answered before he saw me.

"'What?' he barked, squinting to see into the darkness.

"'That's what I said, skipper. If you want to get back those four revs we're losing, I'll have to stop and go astern.'

"'Now I've heard everything,' he said, fully awake. 'You've been stopping at sea for all kinds of excuses. Now you want to go astern.'

"'Sure,' I answered. 'You're pushing a 60-foot whale—that's all that's wrong below, she's pinned to the bow.' After that information sunk in, I continued, 'Why not leave her hanging there until the passengers get up? We'll get in a few hours late, but they'll have something exciting to rave about when they get back home. Then they'll forget all about missing their breakfast in Callao.'

"The old man trailed me down to the bow. Sure enough, to his great surprise, there was the whale.

"'Sorry, Chief,' he apologized, 'I shouldn't of blamed your department for slowing down, but who'd think we were pushing a whale.'

"'Whales sleep on the water. This is the third one I've bumped into in my years at sea,' I told the old man.

"He was a good skipper and agreed to leave the beast there. There was no harm done as we didn't have to arrive at Panama City early. And the passengers were as excited as a bunch of kids—had the most interesting day of their trip. They spent the morning up on the bow, taking photos and movies to show the folks back home.

"Before arriving at the Panama City breakwater, the bridge rang down *stop*, then slow *astern*. When the whale sank,

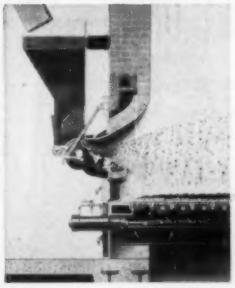
CHOOSE STOKER FIRING FOR ECONOMY AND SATISFACTION

Coal, Burned With a DETROIT STOKER Offers Many Advantages, Proven By Thousands of Installations

- Assured Fuel Supply
- Provides Steam At Lowest Cost
- Dependable—Noted For High Availability
- Maintenance Expense Low
- Requires Little Power For Operation

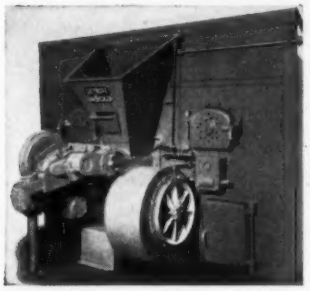
One of these Detroit Underfeed or Spreader Stokers will save you money—they are backed by over a half century of experience.

DETROIT ROTOSTOKER



Spreader stoker with OVER-THROW ROTORS that distribute the fuel uniformly in the furnace. Fine particles burned in suspension and coarse coal, burned on the grate. Four types of grates are available. Roto-Stokers burn successfully an extremely wide range of fuels without any special preparation. In combination with coal, RotoStokers also successfully burn wood and other refuse.

DETROIT UNISTOKER



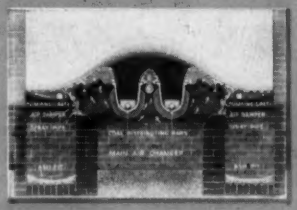
Plunger feed, side-cleaning stoker is available in various sizes for 125 to 250 horsepower boilers. Full-housed blower either motor or steam turbine driven, mounted at stoker front. Adjustable Feed provides for either manual or automatic coal feed control.

DETROIT ROTOSTOKER TYPE C-C

(Continuous Cleaning)

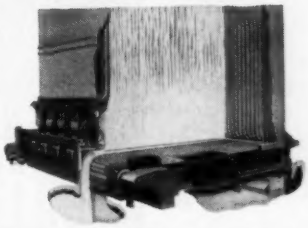
An important addition to the comprehensive "Detroit" line of spreader stokers. Readily applied to small and medium size steam generators approximately 5,000 to 75,000 pounds of steam per hour. The continuous cleaning grates automatically discharge the ash at the front for easy removal. No basement needed.

DETROIT DOUBLE RETORT STOKER



A multiple retort stoker having two retorts, with the side-cleaning feature requiring no basement. Now available with Detroit Adjustable Feed Coal Feed Control. For medium sized boilers.

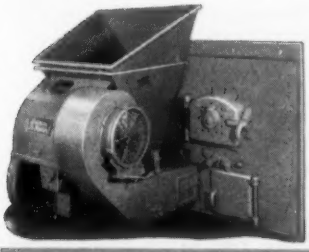
DETROIT ROTOGRATE STOKER



Spreader stoker with FORWARD MOVING GRATES for medium and large boilers up to approximately 400,000 pounds of steam per hour. Screenings or crushed run-of-mine coal used without grinding or pulverizing. Successfully burns a wide range of fuels, including lower grades of Bituminous Coal and Lignites . . . with preheated air if desired. Higher burning rates for longer periods with low excess air and without slagging or clinkering difficulties. Combustible in ash is unusually low.

DETROIT LOSTOKER

Has Detroit Adjustable Feed (Coal Feed Control).



A complete firing unit. Compact—single retort—mechanically driven—plunger feed—side-cleaning design. Many sizes and capacities for various types of boilers. Simple, accessible, dependable. A great coal saver.

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GENERAL MOTORS BLDG., DETROIT 2, MICH.

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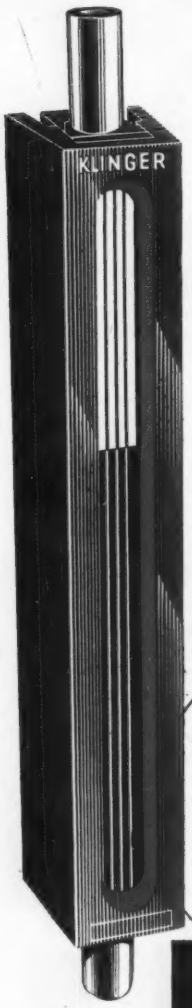
INVESTIGATE DETROIT STOKERS — IT'S THE ROAD TO ECONOMY AND SATISFACTION

TOP LEVEL accuracy



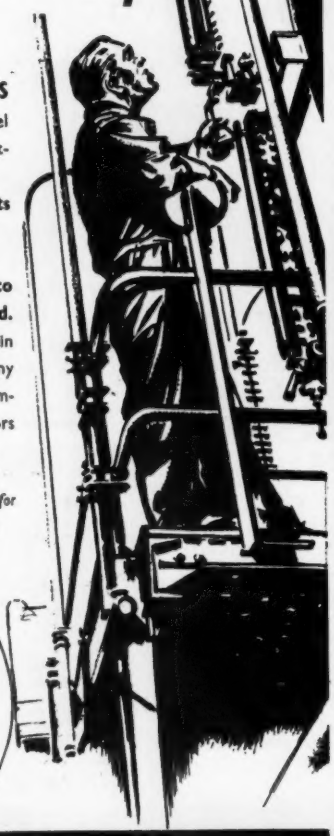
REFLEX LEVEL GAGES

The "K" Type Reflex Level Gage has the following outstanding advantages:—

Single row of tightening bolts
Body free from distortion
Glass easily removed
Gage body turnable, free to expand, and easily removed.

The "K" Type Gage is made in a wide variety of sizes and any number of bodies can be combined to provide level indicators of any length.

Write to your Klinger agent for descriptive leaflets and literature.



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Cables: Klingerit *Tel: Foots Cray 7777*

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MARMADUKE

Continued from page 196

we put the engines *ahead*." Marmy stopped talking, reached for another cup of coffee while we all waited for the climax of his unusual story. After raising draft on his cigar butt, he bellowed, "And another thing, that incident shows you would-be engineers that machinery is like wimmen. It's no use reading about them. If you really want to know them, you got to live with them. Then just about the time you think you have their number—you run head on into a whale." —*SME*

Marmy's Mailbox

'Tis here you exchange blasts with the old boy

WATCH THAT BREW

Shoot me a copy of *The Marmaduke Story* for enclosed check. I have a case of Heniken's Danish beer in the chill room, just waiting for the chance to sit down with old Surfaceblow himself—so don't delay.

C B SHAPLEY *Aruba, N. W. I.*

THAT DRAFT PROBLEM AGAIN

Overlooked "Tall chimney, fan, no draft" in May '55 issue, but got it on the second bounce around our office. I have run into similar situations except that coal and ashes were not spread all over. It happened at Brookhaven National Laboratory where five 1500-hp fans push 300,000 cfm through a stack, 298 ft tall.

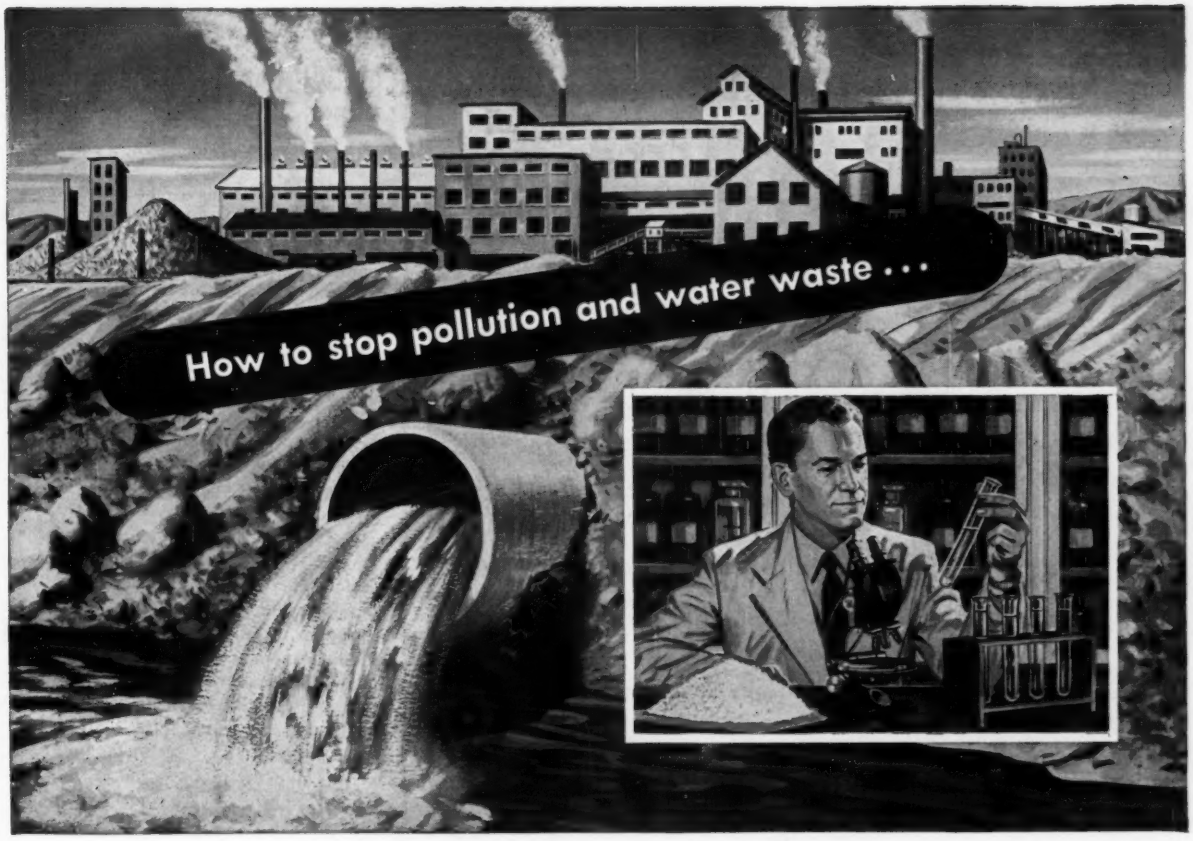
When system was designed, it was expected there would be a positive pressure on fan discharge. There wasn't. After a few hours' operation with warm air, we noted that fans were discharging to pressure about ½ wg below atmospheric. Only problem thus posed was the reconnection of manometers to indicate true reading. We did realize what had happened and it was to our benefit because after that we handled more air at lower hp.

G RITZERT *Baltimore, Md.*

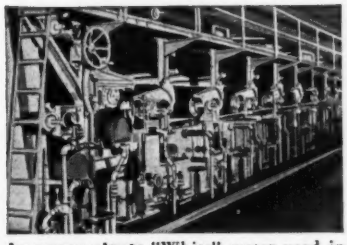
MARMY—FOR FRIENDS

Hope I'm not too late to receive 12 copies of *The Marmaduke Story* in time for Christmas. I need one for myself and 11 for engineers who have been helpful this year in Universal Craftsmen Council of Engineers, No. 22.

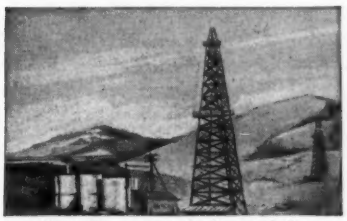
C R KNIGHT *W. Hyattsville, Md.*



CELITE FILTRATION removes harmful impurities and purifies water for re-use



In paper plants "White" water used in paper formation is purified for re-use by Celite Filtration. The Celite method can also provide clean pure process water in many other industrial uses—for boiler make-up, heat exchangers, circulating water for towers, etc.



In oil wells—output is boosted by re-pressurizing wells with water to force out accumulated oil. Celite Filtration purifies water to the extreme degree required—removes the minute suspended impurities which would otherwise clog the microscopic pores of sandstone.

CELITE* FILTRATION can reduce your process water costs materially—and it can greatly aid your community's water conservation and anti-pollution programs.

If your plant now discharges industrial water as waste, Celite Filtration enables you to purify this water for *re-use*—at relatively low cost. Celite removes all types of suspended solids. When required, it even filters out fine matter such as amoebae and algae, many of which cannot be removed by other methods. Thus by recycling process water you can save on water costs . . . and save your community's water.

At such times as you still find it necessary to discharge process water, Celite Filtration is an important anti-polution measure. It helps make water safe and harmless . . . thereby protecting your community's recreational areas, fish and wildlife.

Food processors, beverage manufacturers, swimming pool operators and many industrial users of process water depend on Celite Filtration.

It will pay you to investigate the unique advantages of Celite for your particular application. Celite itself is carefully processed from the purest deposits of diatomaceous earth. It comes in nine standard grades, and you are always assured of utmost uniformity of product. To have a Celite engineer study your problem and offer recommendations, simply write Johns-Manville, Box 60, New York 16, New York. In Canada, 199 Bay Street, Toronto 1, Ontario. *T.M. Reg. U.S. Pat. Off.

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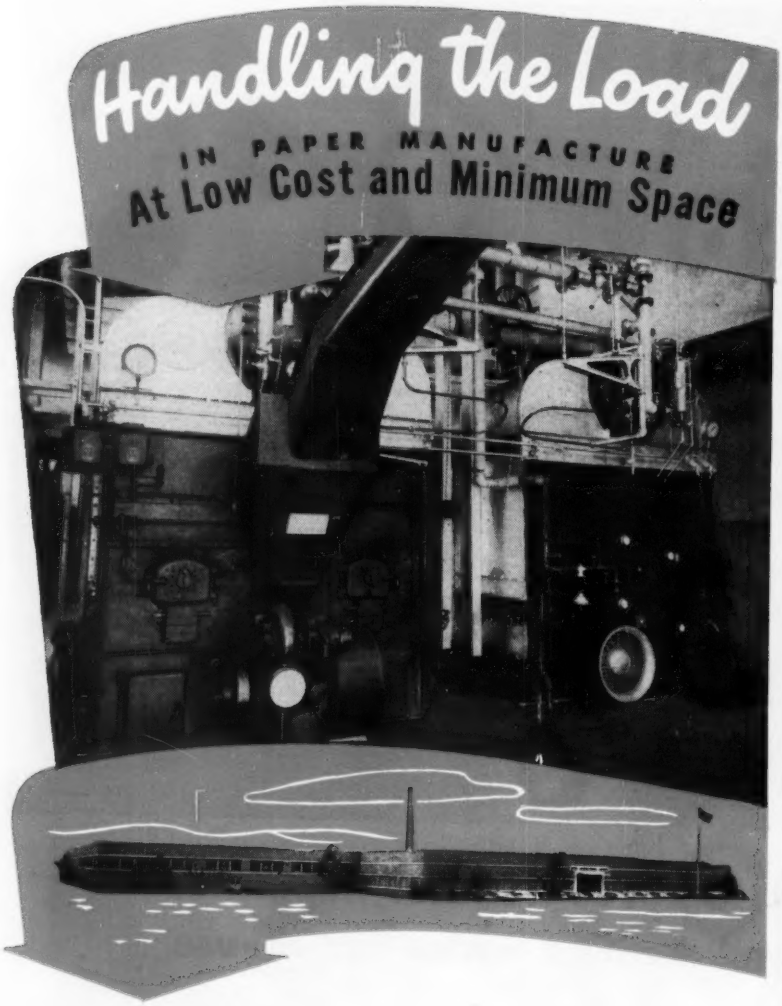
Johns-Manville CELITE FILTER AIDS



TITUSVILLE TICOTHERM

STEAM GENERATORS

For Paper Manufacturers Company, at their Bustleton, Pa. plant, two main types of firing are handled efficiently by these Titusville TICOTHERM Steam Generators. No. 1 boiler has a ram-type underfeed stoker, No. 2 is equipped with oil burner for standby, providing flexibility for all processing and heating needs of the large plant pictured.

Write for your copy of informative Ticotherm Bulletin B-3250A —sent promptly on request.

THE TITUSVILLE IRON WORKS COMPANY
TITUSVILLE, PA.

A division of Struthers Wells

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My bigget boner . . .

For standby, we have one 400-kw and two 200-kw waterwheel generators, plus a 300-kw diesel-driven generator. One Sunday we put on the diesel and a 200-kw unit, then shut down the 400-kw job. We planned to repair the commutator of this larger unit's exciter.

After the 400-kw generator was shut down, I glanced at the switchboard and noticed the load had dropped way off —only about half the usual Sunday load. I wondered why, but since it continued that way for several hours, I shut down the diesel—might as well save fuel. But that's when the fun began.

Soon as I pulled the switch on the diesel panel, voltage and frequency dropped to about two-thirds normal, indicating the remaining machine was heavily overloaded. And when I tried to get the diesel back on the board, I couldn't; instrument fuse had blown. After replacing the instrument fuse and getting the diesel back on the board, load was normal again. So I concluded that the fuse had blown the first time I synchronized, giving a false wattmeter reading. Probably if I had used the voltmeter switch to check the voltage on each phase, I would have discovered the blown fuse.

A D ALLEN *Aspen, Colo.*

CANNED PUMPS

Continued from page 121

the alloy sleeve, Fig. 13. No specific measurement is necessary to determine thrust-face wear. Replacement is necessary only when the face is worn down to the alloy sleeve.

Front bearing inspection or replacement is done as follows: (1) Perform steps (1) through (3), above. (2) Remove the bolts holding the motor section to the pump chamber and separate the two sections, Fig. 1 and 2. (3) Remove the left-hand threaded impeller nut and draw off the impeller by hand, Fig. 3 and 4. (4) Remove the bolts securing the rear bearing housing and pry off evenly, Fig. 5 and 6. (5) Slip the rear bearing out of the housing, Fig. 7 and 8. (6) Withdraw rotor, Fig. 9, exposing front bearing, Fig. 10. Slip out from bearing housing, Fig. 11 and 12. Measure and compare diameter, as before. Replace if necessary.

Reassembly of pump is just the reverse. Be sure to pull up on the housing bolts evenly. Otherwise, the housing may cock and cause rapid and serious bearing wear.

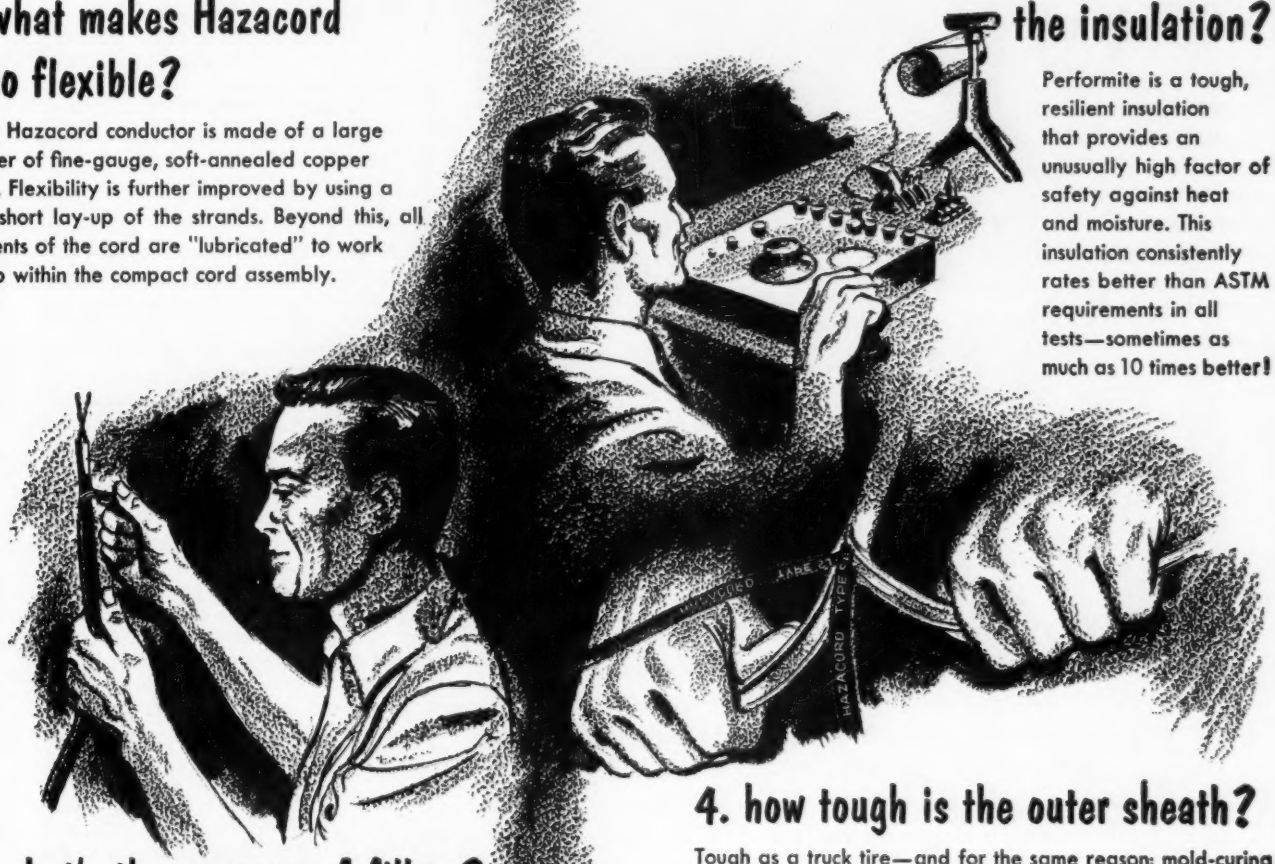
4 points about HAZACORD ...that every cord buyer should know

. what makes Hazacord so flexible?

ery Hazacord conductor is made of a large mber of fine-gauge, soft-annealed copper res. Flexibility is further improved by using a ry short lay-up of the strands. Beyond this, all ements of the cord are "lubricated" to work slip within the compact cord assembly.

2. what's so special about the insulation?

Performite is a tough, resilient insulation that provides an unusually high factor of safety against heat and moisture. This insulation consistently rates better than ASTM requirements in all tests—sometimes as much as 10 times better!



. what's the purpose of fillers?

ey fill out the construction, protecting the insulation m damage by crushing, and give additional gitudinal strength for pulling or suspension. In zacord, these fillers *completely* fill in the area tween conductors without lessening flexibility.

4. how tough is the outer sheath?

Tough as a truck tire—and for the same reason: mold-curing of a properly designed compound. Every foot of the specially-compounded Hazaprene ZBF Sheath is cured in a metal mold. Result: a protective sheath that's tough enough to take just about any kind of treatment in service.

3598

Complete information in Bulletin H-451. Hazard Insulated Wire Works, Division of The Okonite Company, Passaic, New Jersey.

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GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

HOOVER DAM

Continued from page 99

floor plates on the parapet outside the tower could be seen. Total maximum downpull on the gate of 540,000 lb was not considered excessive.

Tests were run at gate openings of 4, 5, 6, 7, 8, 9, 10.5, 12 and 15 inches. After making corrections for elongation of the gate stems to compute true gate opening the maximum downpull was found to be 600,000 lb. This occurs at 4-in. opening with a reservoir elevation of 1168 and tower water level of 1020, Fig. 5.

Vibration and noise developed at all gate openings tested. Sound of flowing water could be heard in the tower when level dropped to 1125. Cavitation noise developed as level dropped to 1100. Intensity of noise and vibration from cavitation increased slowly and then rapidly as level continued dropping to 1040 and below.

The downpull always became unsteady as cavitation came into play. Unsteadiness increased as tower level dropped. Continuous swinging of the strain indicator needle in short arcs showed the unsteadiness in most cases. Sometimes the needle would change position suddenly and vibrate at another level, maximum change was about 50,000 lb per stem. This variation could only be attributed to unstable waterflow patterns under the gate. The maximum indicator readings were recorded every time; Fig. 5 shows the maximums.

To find the conditions at low tower water elevations without going through the severe vibrations experienced with dropping water level, both intake gates were closed. The tower was then drained by opening the needle valves to pull the level down to 915. The cylinder gate was next raised slowly and the needle valves opened slowly to hold the tower water at this level. There was noise from cavitation and the flowing water as the gate opened, but no apparent vibration. The tower water, however, began surging violently and threatened to destroy the float gage. The gate was opened about ¾ in. instead of the intended 3 in. when the test was stopped. Downpull for this opening at elevation 920 was about 50,000 lb per stem.

Gate modification. The tests showed there would be excessive downpull forces and severe vibrations of the tower, gate and penstock during an emergency closing of the gates. To lessen these two hazards part of the lower gate bottom was removed as shown in the inset of Fig. 6. Fig. 8 to 11 show the working platform inside the tower and the nature of the cut

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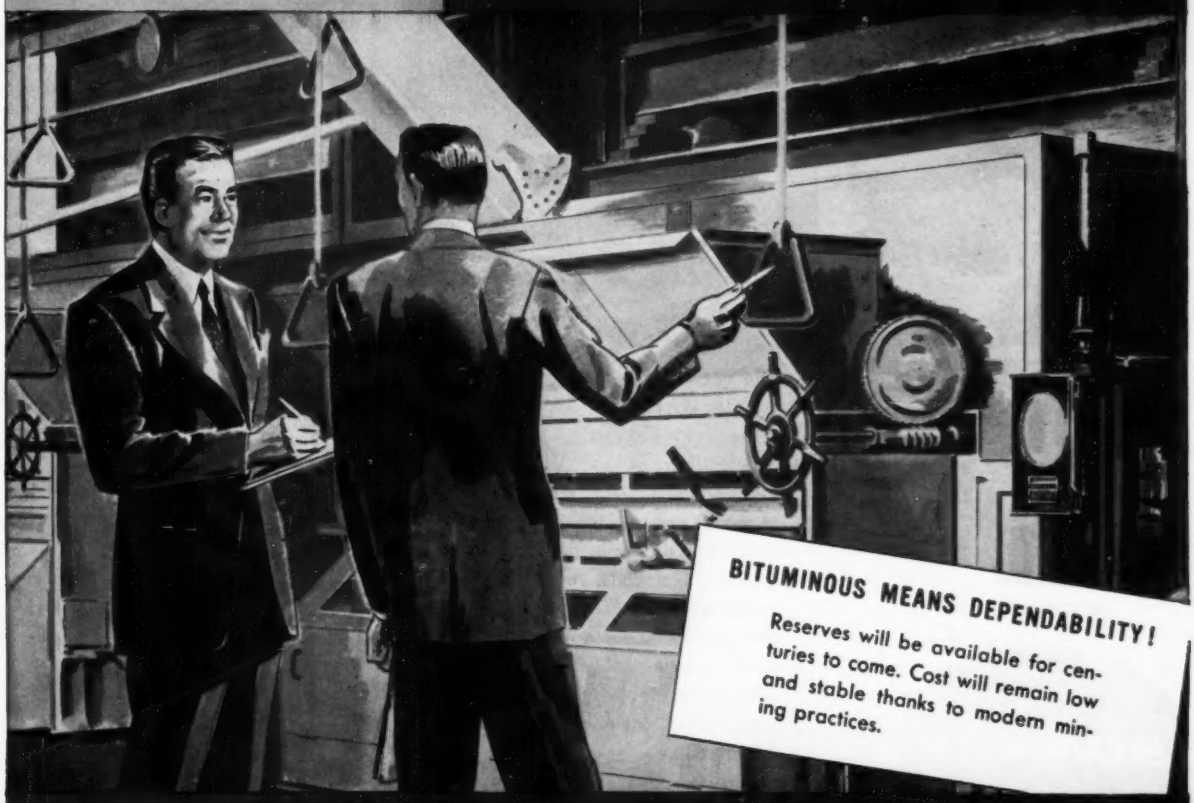

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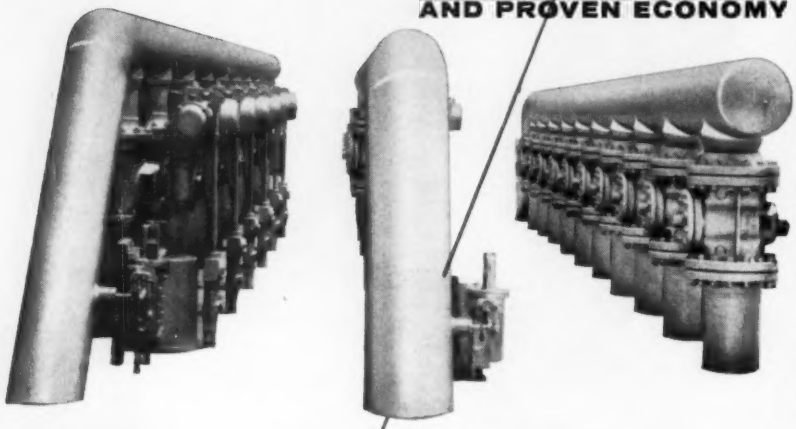
WELDOLETS

FOR ASSURED STRENGTH
AND PROVEN ECONOMY



WELDOLETS

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Are y o u effecting this economy for your company? Neat and uniform appearance is evident in code constructed weldolet headers in this crude oil pipeline terminal. The money saved is in the bank and does not appear in this picture. If you are not using the weldolet method of cutting piping costs, write today for information.

BONNEY

SOLD THROUGH LEADING DISTRIBUTORS

WELDING FITTINGS DIVISION
BONNEY FORGE & TOOL WORKS
350 GREEN ST., ALLENTOWN, PA.

HOOVER DAM

Continued from page 202

made to reduce the area of the gate bottom.

Final tests were run in Oct 1953 to find the effect of the gate modification. With a reservoir level of 1155 and a 3-in. gate opening there was no noise in the tower until the water level reached elevation 1100 when a rumble of flowing, turbulent water was heard. The rumble increased gradually as the level dropped.

At about 1055 there was a sudden noise change to that of water falling into a pool. This happened as the top of the upper cylinder gate became exposed. There probably was leakage through the top seal of this gate. As the tower level kept dropping to 1000 the rumbling increased and movement registered on a vibration pickup. The floor plates in the tower parapet began to vibrate. At 955 the noise was still intense but the vibration and rumble decreased somewhat. Conditions were about the same at elevation 940.

While the noise and vibration were severe, the intensity was substantially less than with the original gate. Modification had not entirely eliminated cavitation on the bottom surface.

The tower level was not dropped below 940 because water surging increased rapidly as the level neared the gate. Maximum total downpull on the gate was 133,000 lb with tower level of 1010. This force, the maximum for the tests was about 25% of that for the 5-in. opening of the original gate. Fig. 6 shows the downpull variations for the modified gate with reservoir elevation of 1155.

Fig. 7 compares the downpull forces on the gate before and after modification with the reservoir at normal high elevation of 1229. The maximum will now be less than 200,000 lb compared with an original of almost 900,000 lb. As a result of these tests all the lower gates of the Hoover Dam intake towers have been modified. They should now be ready to close without trouble if a major break occurs in the penstock system or the needle valves.

POWER *gratefully acknowledges the assistance of L J Hudlow and S H Poe, U.S. Bureau of Reclamation, in furnishing data, illustrations for this story.*

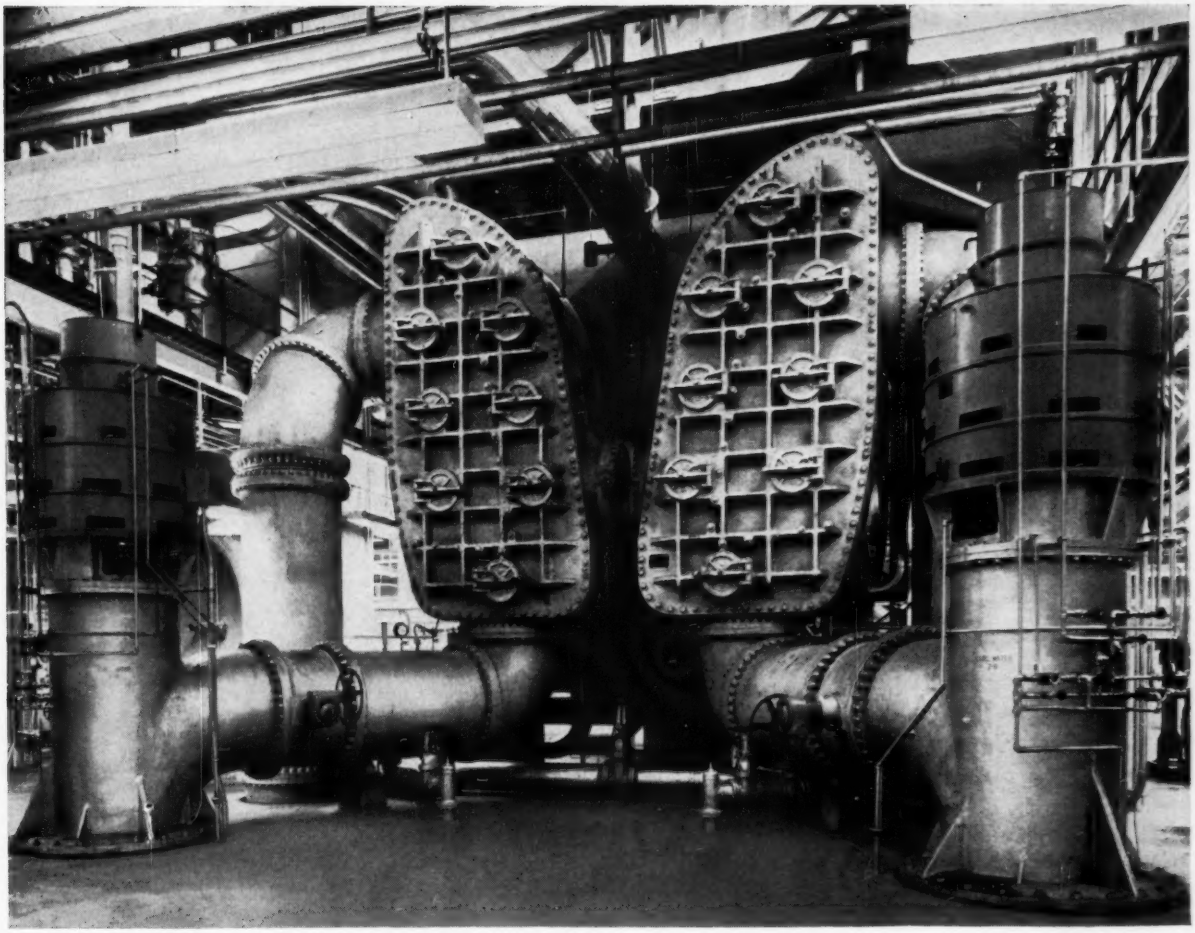
More ARGUMENTS

Begins on page 144

Many apparent advantages

(Continued from center column)

surges in supply or makeup requirements. If there is a steam shortage during abnormal operation, high-pressure steam can be admitted through a



TWO MORE FW surface condensers installed by ALABAMA POWER CO.

Two, 87,000 sq. ft. cross-flow, two-pass condensers serve new 125,000 kw turbines at Barry Station, Mobile, Ala.

The huge Foster Wheeler surface condenser shown above is one of two duplicate units recently installed at Alabama Power Company's Barry Station in Mobile, Alabama. Each of these two 87,000 sq. ft. cross-flow, two-pass condensers serves a 125,000 kw turbine, condensing 650,000 pounds of steam per hour with 89,100 gpm of circulating water at 80F. Turbine exhaust pressure is 1.87 hg.

Alabama Power's confidence in FW condensers is based on long experience. Including units installed, under construction and on order, *seven* large Foster Wheeler surface condensers have been purchased for various stations on the Alabama Power Company system.

For information on FW condensers to meet your steam-plant requirements, contact your Foster Wheeler representative or write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

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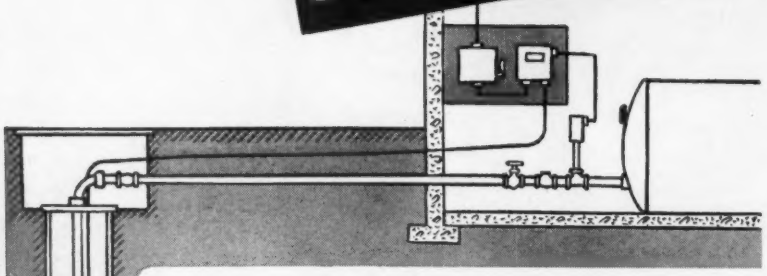
A New Lift for plant water supply needs!

THE COMPACT, HIGH-CAPACITY
SUMO SUBMERSIBLE

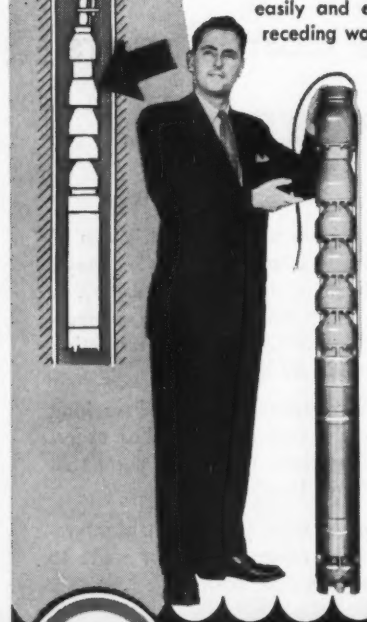


Here's a commonsense pump for any plant that depends on a deep well water supply. The SUMO SUBMERSIBLE employs a time-tested design backed by over 30 years experience in the manufacture and application of submersibles, exclusively.

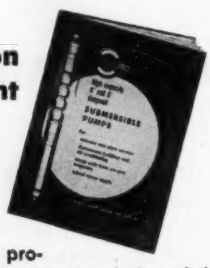
Pump and motor — coupled together as a unit — operate inside the well, underwater. No pump house is needed.

Water delivery is obtained by *pushing* — not by suction. Since the water is under pressure, there are no priming problems. Shaft alignment troubles, common to pumps in which the motor is surface mounted, are eliminated.

What's more, the SUMO SUBMERSIBLE can be quickly, easily and economically set deeper to compensate for receding water levels.



Information every plant engineer should have . . .



Bulletin B-1000 provides a comprehensive description of the SUMO SUBMERSIBLE PUMP—and its many advantages as a basic water supply pump for industry.
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More ARGUMENTS

Begins on page 144

pressure-reducing valve to maintain suitable operation without interfering with plant economy.

Because of these advantages, some engineers are today advocating deaerating heaters, while 10 or 15 years ago they favored deaeration in the condenser hotwell. Probably there are also some engineers who formerly used deaerating heaters and now depend on surface condensers.

It's my impression that a large majority of design engineers prefer deaerating heaters. Furthermore, the percentage of these has not diminished in the past 10 or 15 years.

J D YODER *The Permutit Co*

Reader Pef's argument

(Continued from third column)

4. It acts as a receiver for miscellaneous drips and returns from which no heat is lost.

5. It can receive cold makeup without danger of increasing oxygen content of the deaerator effluent. Oxygen content of the condensate from the closed-cycle main condenser might increase if the cold makeup entering the condenser caused subcooling below the temperature corresponding to the absolute pressure. Oxygen is more soluble in colder condensate.

Standards of the Heat Exchange Institute quite clearly indicate the limits of effective deaeration in a surface condenser.

6. This deaerator provides insurance against any oxygen passing to the boilers in case of air leaks in the vacuum system, tube failures or improper functioning of air-removal apparatus.

7. It costs no more when you consider all items like closed heater, storage, controls and condenser modifications to effect deaeration.

About 15 years ago when boiler pressures were much lower, a prominent firm of consulting engineers studied the subject. They believed the open feed cycle was better because it gave assurance of complete deaeration even under abnormal operation. Recent surveys stress the damaging results of small quantities of oxygen in the boiler feed system. With the present high boiler pressures and the trend toward "once-through" boilers, chemical scavenging can no longer be safely used in quantities sufficient to guard against such transient conditions.

When all facts are considered, I think the advantages of the pressure deaerator outweigh those of the deaerating condenser.

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Nordberg, a pioneer in the Diesel and Gas engine industry in the United States, has always occupied a prominent position among the world's leading builders of internal combustion engines. Over the many years Nordberg has contributed many of the most notable advancements in the development of more efficient prime movers . . . all in the interest of improved fuel economy, simplicity of design, less maintenance and better overall performance.

Nordberg research, engineering and development continues to direct its efforts toward further achievements by intelligently anticipating power requirements. As a result of these efforts Nordberg today . . . with a full range of engine sizes from 10 to over 12,000 horsepower including Diesel, Duafuel® and Spark-Ignition Gas types . . . is in the best position to solve your specific power problems.

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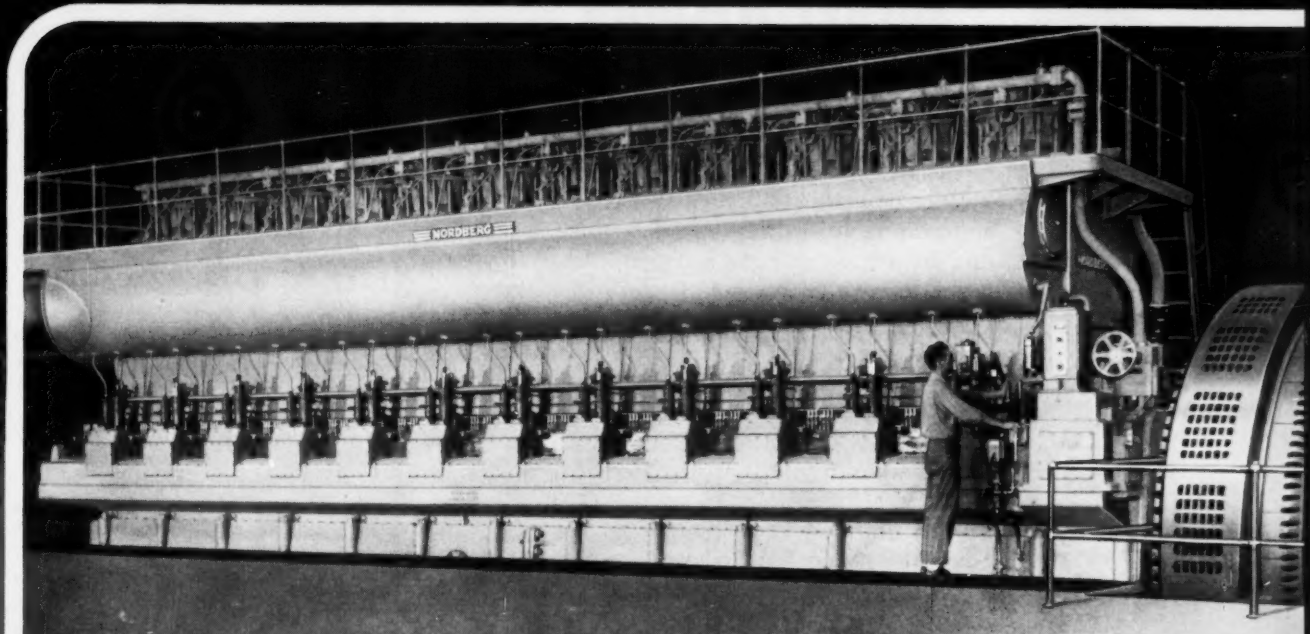

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P156

2 Safe Ways to PROTECT Pressure Piping...

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Pipe joints are potential trouble spots in high pressure piping systems. Change in direction of flow causes turbulence, erosion and vibration. Watson-Stillman fittings are made to absorb this type of punishment. They're drop-forged for strength and toughness and safety-factor designed for the protection of your piping.

Choose between a welded piping system and a screwed one to suit your needs. Then choose W-S Screw-End or Socket-Welding Fittings to join your pipe. They're available in sizes ⅛" to 4" for piping up to 6000 lb. W.O.G. class. For high temperature or corrosive service you can get W-S Forged Stainless and Alloy Steel Fittings, too. Send today for our informative catalogs.

W-S FITTINGS DIVISION

H. K. PORTER COMPANY, INC.
Roselle, New Jersey

ENGINE KNOCK

Continued from page 119

pression ratio. Have enough clearance between piston and head. See that valves don't strike piston—which often happens. (6) If all these measures fail, change fuel cam design so fuel is injected more slowly at first, or over a longer period. Then with same ignition delay there's less fuel in cylinder when firing does take place. Don't make this change without advice of pump or engine manufacturer, or a specialist.

Some pumps inject a little fuel, stop injecting until fuel has chance to ignite, then inject remainder. Such pumps are very good against knock. (7) Supercharging an engine usually reduces knock, but that's impractical in existing engine.

Spark-ignition engine. (1) Try retarding spark. If this gives no help, put it back where it was. (2) You can often tell preignition from detonation by slightly less "ping" in the sound. If plugs or distributor are dirty, or if cylinder fires after its ignition lead is removed, check preignition. Follow up suggestions in chart. Spark-plug type unsuitable for engine may cause preignition when electrode gets very hot in running. (3) If engine is carboned, clean it up anyway. Carbon can cause detonation, pre-ignition, or both. (4) If engine seems overheated but coolant temperatures are normal, clean the water spaces. If coolant itself is too hot, increasing flow rate may help. In a closed circuit, just increasing the quantity of water in circuit may do it. You may need bigger radiators or cooling towers, heat exchangers, etc. Also, try better air supply to radiators, towers etc. Last, cleaning out system may still help. (5) Try a richer mixture in liquid-fuel engines. (6) If engine is supercharged, you may need to install aftercoolers or to make the present ones more effective. (7) If exhaust valve is far from plug, it may produce a local hot spot, causing detonation. A sodium-cooled valve may help. (8) Reduce compression ratio.

Dual-fuel engine. Check to distinguish between diesel knock and detonation. Proceed accordingly, reading "pilot injection" for "spark" if it's detonation, except where obviously inappropriate. Too low cetane number of pilot fuel may cause knock. The cetane number should never be below 35; 45 is better. But watch out for the following: (1) If you put compression ratio up to reduce diesel knock, you may detonate when running on gas. (2) If you reduce compression to reduce detonation, you may be unable to start as diesel fuel may not ignite.

New whisper engine. A knockless

Motor Burnouts

are preventable!

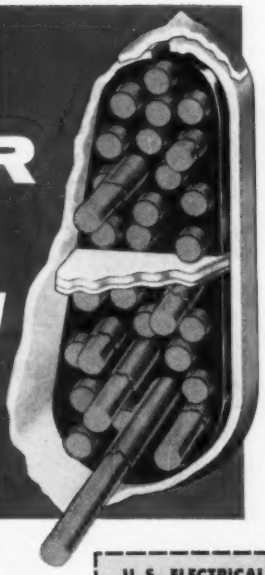
Eliminate causes and avoid failure

Extensive surveys reveal the astonishing fact that a large percentage of motor burnouts occur from *avoidable* causes such as overload, clogged passages or confined spaces, improper circuit protection and bearing failure. These conditions, if not corrected, result in overheating of the windings. Ordinary insulations are organic and will carbonize when excessively heated, resulting in motor burnout.

As a means of increasing motor life and to resist burnouts the windings in U.S. motors are insulated with inorganic *asbestos*, greatest of heat-resisting elements and Nature's only incombustible fiber.

Asbestos is used in sheet form to separate the windings and in a compounded form, vibro-applied, as a filler to completely isolate each wire. Coil ends are further protected with a built up armor of several coatings of an asbestic compound that smooths the surface and forms an impervious protection against moisture.

In Bulletins portraying the outstanding features of U.S. Uniclosed, Varidrive, Syncrogear and Totally-Enclosed motors, the application of asbestos is interestingly presented, proving its life-lengthening characteristics. Get these Bulletins. Mail the Coupon.



U. S. MOTOR WINDINGS

Asbestos-Insulated to resist burnouts

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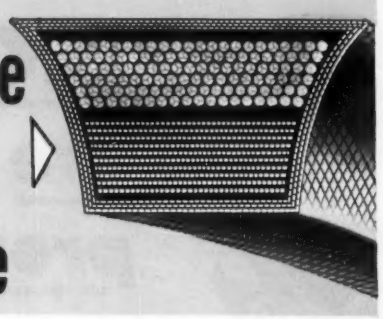
Why this curve lengthens V-belt life



THE CONCAVE SIDES (U.S. Patent 1813698) of every Gates V-Belt are a precisely engineered curve. This curve greatly lengthens V-belt life for this interesting reason:

When you bend a Gates V-Belt, just as it is bent around a sheave, the concave sides (Fig. 1) become straight. Therefore, the belt makes full contact with the sheave, gripping the sides evenly (Fig. 1-A) and wear is distributed uniformly across the sidewalls of the belt. Naturally, uniform wear lengthens belt life; saves on replacement costs and cuts down-time.

Now see what happens when you bend a straight-sided belt. (Fig. 2) Just feel the sidewalls *bulge out* at the bend. The bulge causes *uneven* contact with the pulley, as in Fig. 2-A. And uneven contact causes excessive wear at points shown by arrows; belt life is shortened.

Cut costs by getting longer wear from your V-belt drives. Specify Gates Vulco Rope—the V-belt with concave sides. Your nearby Gates distributor will supply your needs promptly. The Gates Rubber Co.—*World's Largest Maker of V-belts.*

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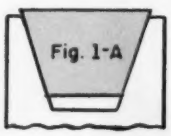
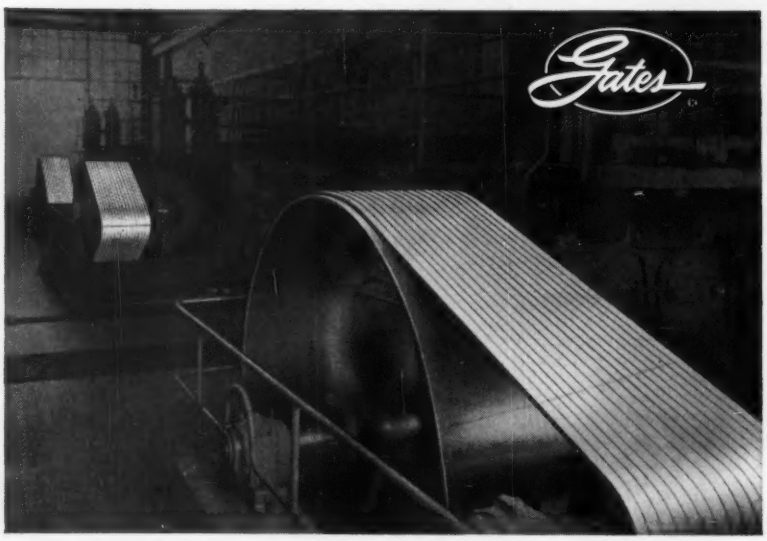
TPA-74





Gates VULCO ROPE Drives

ENGINE KNOCK

Continued from page 208

diesel has been produced in Germany and manufacturing licenses are being negotiated. In this engine, fuel is sprayed as a nonatomized jet onto the piston, except for a small quantity of atomized spray to initiate combustion. Fuel on piston burns as it vaporizes on hot-metal surface. So there's no fuel accumulation in combustion space to cause knock. It cannot burn in liquid state lying on the piston.

BUCKET VIBRATIONS

Continued from page 83

condition can be satisfied, then dangerous resonant vibrations will be avoided.

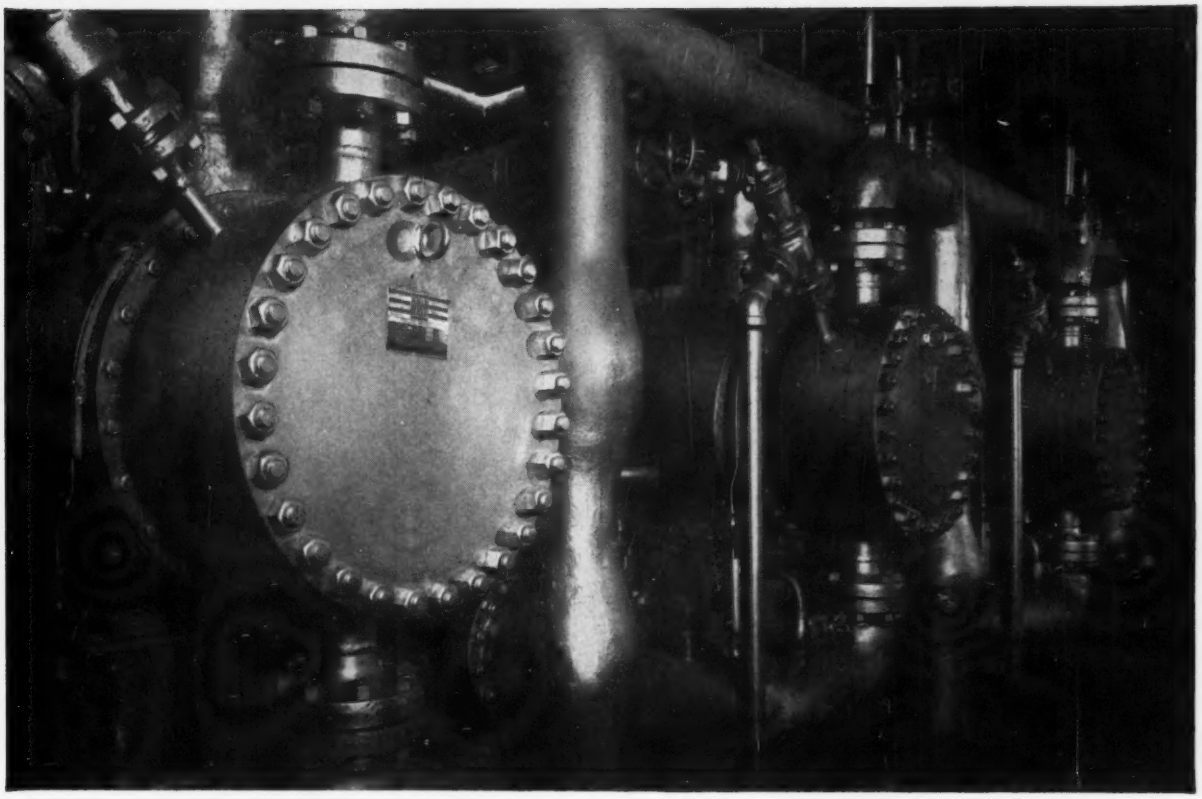
Design procedure. As mentioned before, the forcing frequency is the nozzle passing frequency, which equals the turbine speed in revolutions per second multiplied by the number of steam nozzles around the circumference. Changing the number of nozzles to be used is the only practical way of adjusting the forcing frequency.

Fig. 9 shows the quiet zone covers a range of frequencies from 6800 to 8700 cps. Let us assume the turbine must run at 10,000 rpm; this equals 167 rps. To place the nozzle passing frequency in the middle of the quiet zone we must choose the proper number of nozzles. Dividing the nozzle passing frequency by the speed in rps we get the number of nozzles that must be used. If we want a nozzle passing frequency of 7700 cps at a speed of 167 rps, then $7700/167 = 46$ nozzles. The nozzle diaphragm is then designed so it has 46 equally spaced steam nozzles around its circumference.

At the turbine operating speed of 10,000 rpm there are no dangerous bucket vibrations from the nozzle stimulus since the nozzle passing frequency occurs within a quiet zone.

This approach to the problem of bucket vibration depends completely on our ability to accurately locate the quiet zones in the frequency spectrum. This is done by vibration-testing the completed turbine wheels before installing them in turbines. The vibration tests need special equipment and experimental techniques to get useful results. The vibration records must be carefully interpreted and analyzed.

A Vibration Investigation Center, a part of our engineering organization, does this vibration testing to enable the design engineer to guard against vibration problems in turbine buckets. The Center is controlled, operated and directly supervised by engineers familiar with design details. With proper guid-



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Simply stated, Ross designs and manufactures heat exchangers for virtually all conditions and applications, particularly units of a highly specialized nature, such as high pressure power plant equipment...bleeder heaters and fuel oil heaters, for example.

The installation of 6 Ross High Pressure Fuel Oil Heaters (illustrated) at the Pacific Gas and Electric Co.'s Station P Steam Plant in San Francisco is typical. Featuring forged oil channels with integral tube sheets and a double tube sheet arrangement to insure against any possibility of fuel oil contaminating the steam system, these rugged units demonstrate Ross' resourcefulness and experience in dealing with both the average and the specialized power engineering problem.

Your requirements, too, can be met with the same, exacting Ross attention to details. Inquire now. Ross offices are in all principal cities.

For recommendations on specialized heat exchangers, as well as on surface condensers, turbine oil coolers, engine oil and water coolers, compressor inter and after coolers and related power plant equipment, you'll profit by consulting a Ross engineer.

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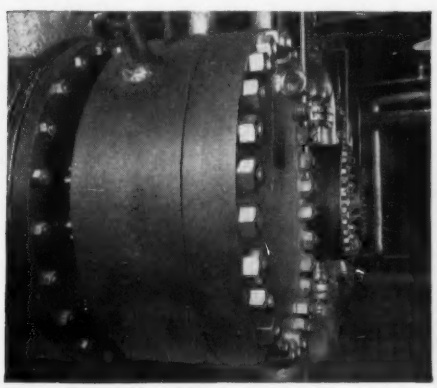
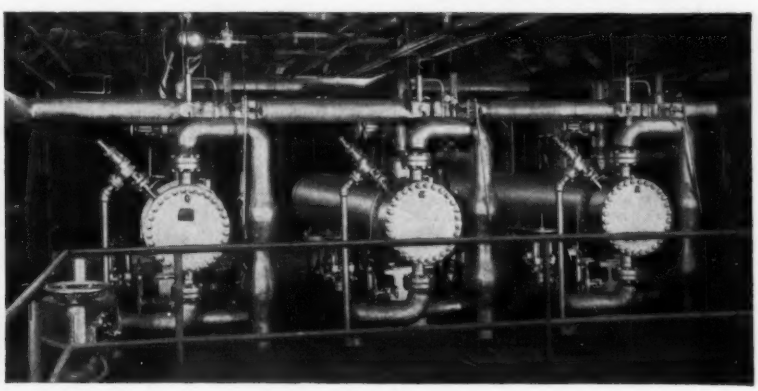
In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.





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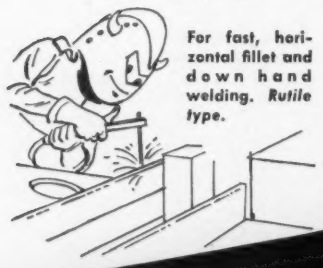

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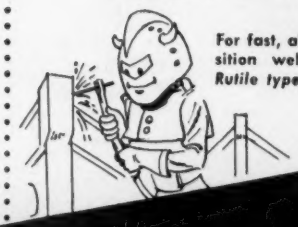

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BUCKET VIBRATIONS

Continued from page 210

ance the test effort can be concentrated in areas that show the greatest promise of producing improvements in turbine-bucket design.

A continuing development program improves our knowledge and understanding of turbine-bucket vibrations. This helps to incorporate new developments in turbine-bucket designs to improve their dependability in operation.

PROCESS WATER

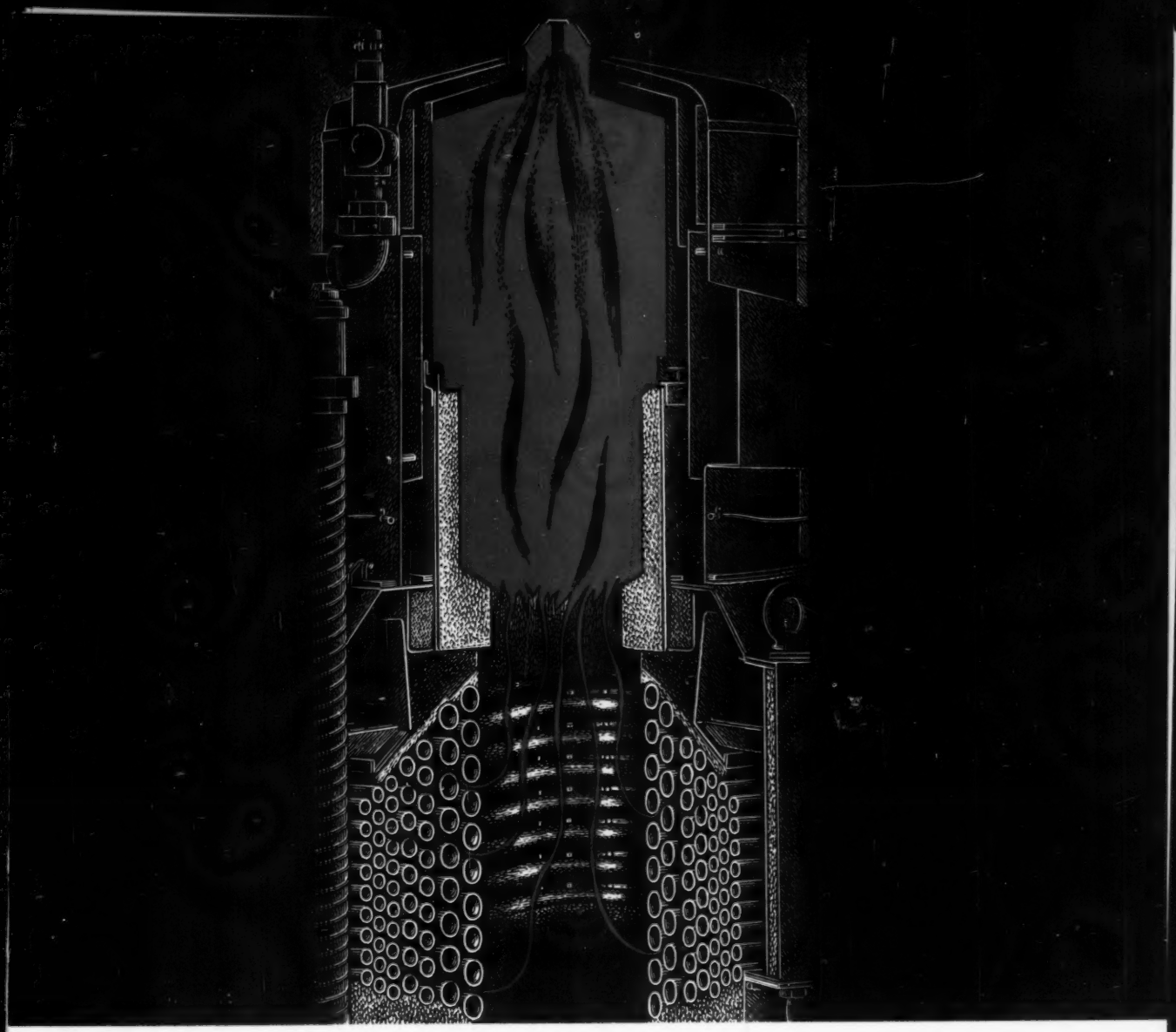
Continued from page 93

This process does not soften the water and is used only to remove iron and manganese. It differs from sodium zeolites, which both soften and remove iron and manganese. Manganese zeolite removes iron and manganese by oxidation and filtration, sodium zeolite by ion exchange.

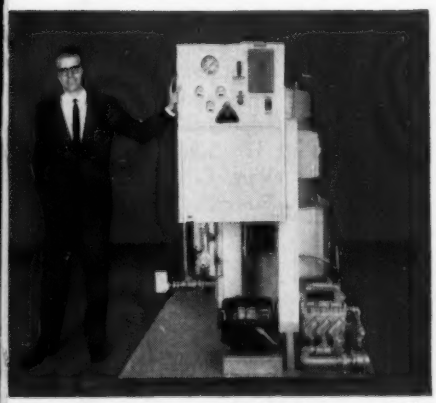
Insoluble hydrated oxides, which collect in the manganese zeolite bed, are removed by periodic backwashings of the filter. Flow rates range up to 3 gpm per sq ft, backwash rates are 8 gpm per sq ft. Capacity of the manganese zeolite is 0.09 lb of iron or manganese per cu ft and the amount of potassium permanganate required for regeneration is 0.18 lb per cu ft. As the latter is rather high priced, this process in industry is generally limited to waters not containing more than 1 ppm of iron or manganese. For these it eliminates aeration and the double pumping usually required in plants where aeration is used.

Iron or manganese, present as soluble bicarbonates, may be removed together with the hardness by the familiar zeolite (sodium-cation exchanger) process carried out in pressure equipment. Completely automatic zeolite softeners are available. Zeolites used for iron, manganese and hardness removal are the resin, carbonaceous or greensand type. When using this process for iron and manganese removal, take care that the water does not contact the air before it passes through the zeolite softener.

Cold-lime or lime-soda process is one of precipitation in which the lime or lime soda are added to the cold water where they react with the hardness constitutents to produce precipitates that are removed by settling or by settling and filtration. Calcium alkalinity may be reduced to 2 gpg or total calcium hardness to the same value and magnesium hardness to 2 gpg also. So the total hardness (calcium and magnesium) may be reduced to 4 gpg. Since many process waters



more steam, faster steam in less space



See how small, how compact, 100 h. p. can be!

Water, force-circulated through a Modulātic Steam Generator, absorbs heat more thoroughly because of splitting gasses into thin wiping films over many uniquely spaced heat-transfer surfaces. This unique spacing is a result of Vapor's exclusive water-tube design.

This provides more steam from much smaller boiler rooms in new plants—makes possible addition of steam in already crowded plants. The entirely self-contained, fully automatic Modulātic unit can be moved through existing doorways and installed in unused corners or other out-of-the-way spaces.

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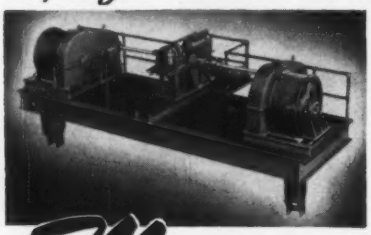

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PROCESS WATER

Continued from page 212

require more complete softening, the combination lime-zeolite process, described in the next article, may be used.

Because of the high pH afforded in the cold lime-soda process, manganese and iron may be removed efficiently by aerating the water ahead of the softener. Sludge-blanket type of equipment is especially efficient as it brings the water into intimate contact with previously precipitated material as it filters upward through the blanket. Fig. 5 shows the design used, arranged so the raw water is thoroughly mixed with, and then filtered through, previously formed sludge. This intimate contact with the solid phase inhibits super-saturation, producing a stable effluent. Because of this, the precipitator detention period need be only one hour, instead of the four hours needed in older types.

For process waters, filters are almost always used to remove the last traces of iron or manganese-containing precipitates. If completely softened water is required, the lime-zeolite process, discussed in our second and concluding article, may be used.

More FREE LITERATURE

Begins on page 171

ELECTRICAL EQUIPMENT

9 **Motor control center** permitting savings of up to 50% in floor area is detailed in 24-p bulletin GEA-6367. Contains construction and application data; lists ratings, weights, dimensions. General Electric Co, Distribution Assemblies Dept, Plainville, Conn.

10 **Flat-plate batteries** are illustrated and described in 4-p bulletin 5785. Large cutaway drawing shows construction details of positive plate. The Electric Storage Battery Co, Exide Industrial Div, Box 8109, Philadelphia 1, Pa.

11 **Enclosed capacitor** equipments for high-voltage installations are described in 12-p bulletin GEA-2860D. Covers application of ready-assembled equipments ranging from 600 to 5400 kvar, 2400 volts and above, to reduce voltage drop and cut power losses. General Electric Co, Schenectady 5, N. Y.

12 **Transformers.** First *Hy-Bute/60* outdoor current transformer is detailed in 8-p bulletin GED-2727. Includes data on application, construction, mechanical and thermal ratings. General Electric Co, Schenectady 5, N. Y.

13 **Substations** for light load areas are subject of 8-p bulletin 11B7895A. Lists material furnished for high- and low-voltage structures and diagrams optional

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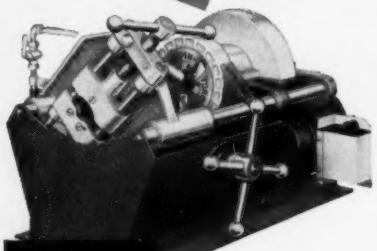

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Spin Torque Chucking
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Toledo Spin Torque Chuck For Faster Production

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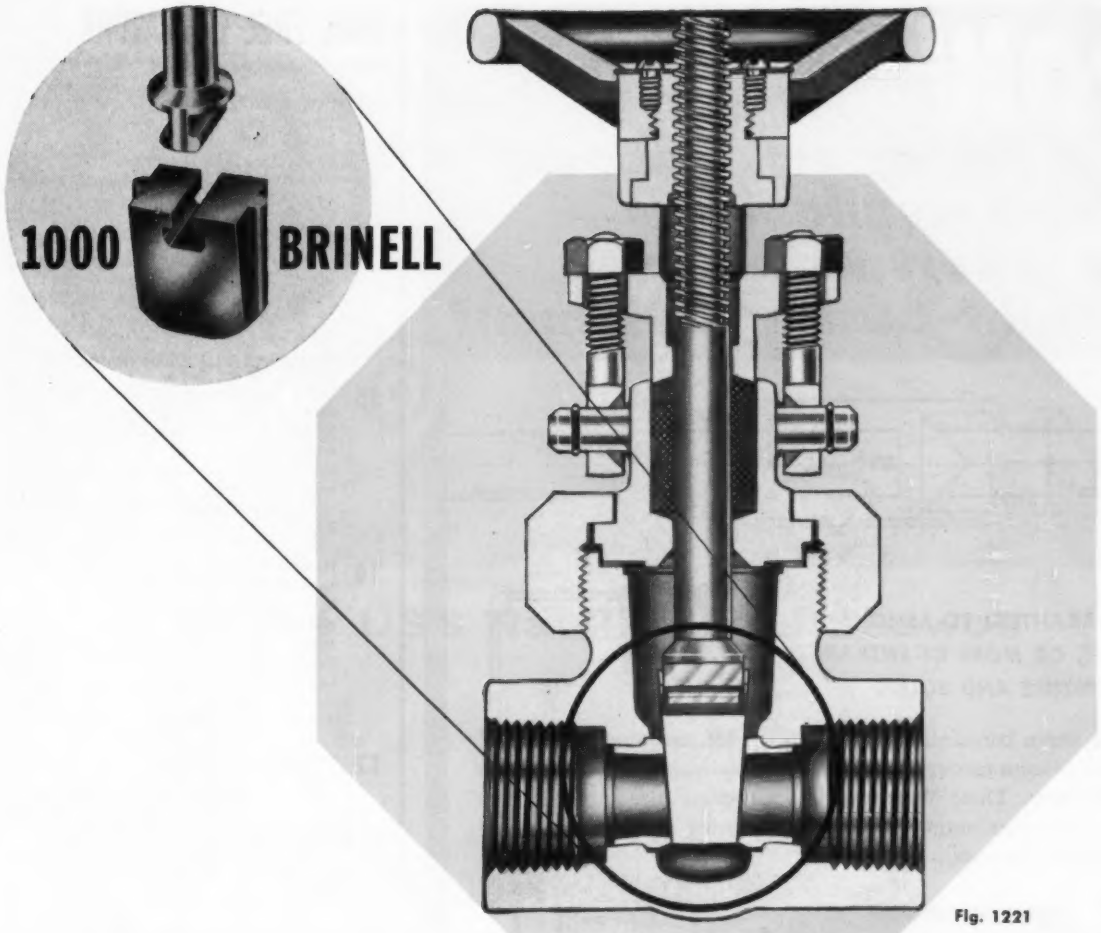

Fig. 1221

Stop Galling with the hardest valve wedges you can buy

Highly resistant to erosion and corrosion

Here's a wedge as hard as flint . . . so hard that it's undamaged by pipe cuttings, scale or grit. It's the only trim we know of which will successfully withstand the simultaneous attack of the three valve-destroying agents—corrosion, erosion, galling. This wedge is *13% chrome stainless steel hardened up to 1000 Brinell.*

Specify the OIC 1221 gate or 1621 globe where you need the extra rugged nature of forged steel. They are recommended for steam service up to 800°F...oil service up to 1000°F. Or, use these same valves for hydraulic service up to 2000 lbs.

Write for Form 195 for specifications on the OIC forged steel line.

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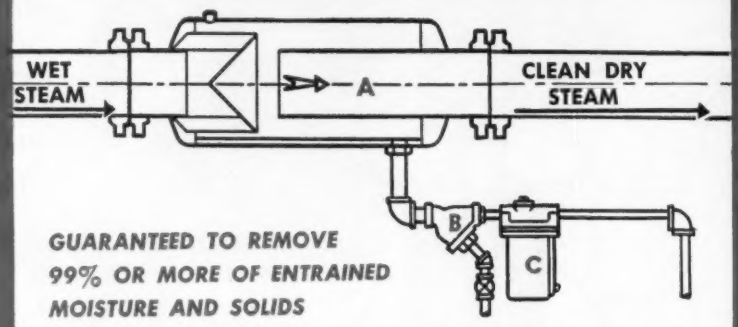
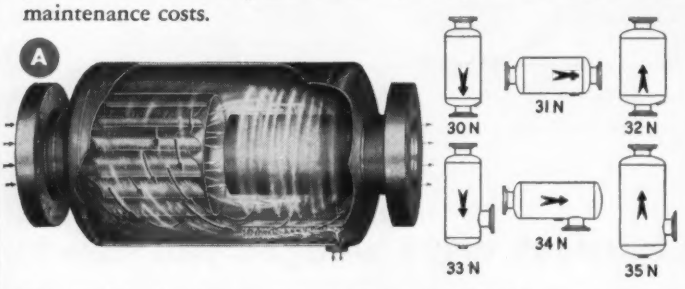
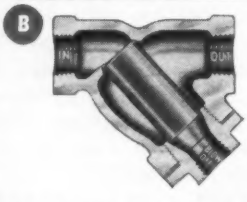


GUARANTEED TO REMOVE 99% OR MORE OF ENTRAINED MOISTURE AND SOLIDS

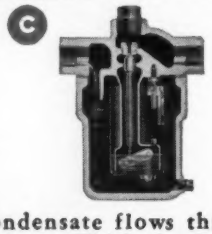
Live steam containing condensate, boiler compound, scale and other foreign matter is detrimental to equipment and is costly to super heat. These Wright-Austin accessories are engineered to give you maximum purification, resulting in lower fuel and maintenance costs.



This Wright Austin separator employs centrifugal force to remove impurities from steam, air or gas flow. The Type 31N, as well as other Models shown, are light weight, compact and sturdily constructed according to the ASME Code.



Foreign matter drains to Wright-Austin "Y" Type strainer which catches solids. These are periodically blown out by opening drain valve.



Condensate flows through strainer to Wright-Austin "Airxpel" Bucket trap. This unit automatically drains condensate as collected.

WRITE FOR NEW CIRCULAR 506-A

WRIGHT-AUSTIN COMPANY

3245 WIGHT STREET • DETROIT 7, MICH.

More FREE LITERATURE

Begins on page 171

arrangements for each. Allis-Chalmers Mfg Co, 952 S 70th St, Milwaukee, Wis.

14 **Lighting.** Bulletin L-110-B gives full information on low-brightness curved-lens panel. Included are brightness data, coefficients of utilization, formulas for calculating illumination levels. Corning Glass Works, Lighting Sales Dept, Corning, N. Y.

HEAT-TRANSFER EQUIPMENT

15 **Heat exchanger** made in single- and two-pass designs is described in 2-p bulletin supplement 12-HS. Includes data on features, construction, dimensions. Schutte and Koerting Co, Dept HT-D, Cornwells Heights, Bucks County, Pa.

16 **Heat-transfer** bulletin HE contains data and illustrations of interest to designers and users of custom-built heat-transfer equipment. Included are a table of heat-transfer rates, tube-sheet layout tables and a sample calculating sheet. Downingtown Iron Works, Inc, Downingtown, Pa.

17 **"Alloys** for heat-exchange problems in modern power plants" is title of 28-p illustrated bulletin. Presents typical installations of cupro-nickel or nickel-copper alloys. The International Nickel Co, Inc, 67 Wall St, New York 5, N. Y.

18 **Quick-opening door** for heat exchangers, sterilizers and autoclaves is subject of 4-p bulletin 2030. Fully illustrated. Patterson-Kelley Co, Inc, East Stroudsburg, Pa.

19 **Sections** used to build cooling and condensing systems for process fluids are detailed in 24-p bulletin HT-23. Contains design features, installation data, typical installations. National - U.S. Radiator Corp, Heat Transfer Div, 342 Madison Ave, New York 17, N. Y.

MAINTENANCE EQUIPMENT AND MATERIALS

20 **Vibration mountings** used to isolate vibration, noise and shock caused by light- and medium-weight machinery are detailed in 4-p bulletin RS-55. Describes units with load capacities ranging from 40 to 10,000 lb. T R Finn & Co, Inc, Industrial Div, 200 Central Ave, Hawthorne, N. J.

21 **Interior coatings** for pipes and tanks. Illustrated 4-p bulletin lists specs concerning surface preparation and application of coatings to combat corrosion Cook Paint and Varnish Co, Box 389, Kansas City 41, Mo.

22 **Stopping corrosion** with pvc linings is subject of illustrated 4-p bulletin. Contains physical and chemical characteristics, advantages and disadvantages of three

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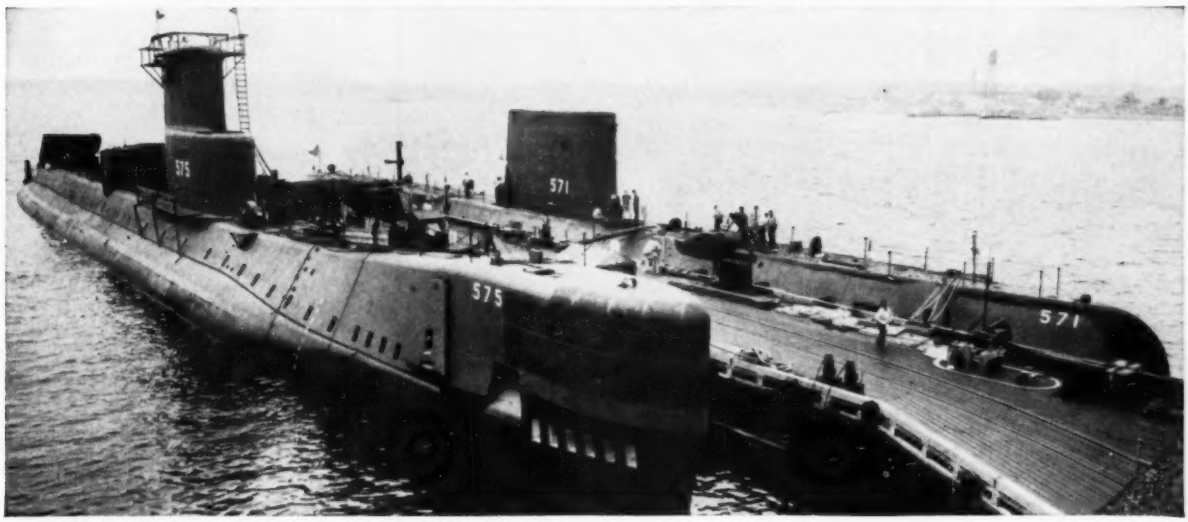

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More FREE LITERATURE

Begins on page 171

most commonly used types of pvc protection. Kaykor Industries, Inc, Yardville, N. J.

23 **Micronic filter** for lube, fuel and hydraulic liquids on diesels, machine tools, special machinery is described in 8-p catalog SAK-057. Includes diagrams, charts, full specs. The Cuno Engineering Corp, Meriden, Conn.

MATERIALS HANDLING

24 **Technical reprint** illustrates how bulk materials may be successfully moved by air in many industries. Presents typical systems. Illustrated 4-p bulletin GDM-35. Fuller Co, Catasauqua, Pa.

25 **Belt conveyor idler.** Flexible 2-bearing suspension - type unit shapes itself to the load. Illustrated 4-p bulletin LD-103. Joy Manufacturing Co, Henry W Oliver Bldg, Pittsburgh 22, Pa.

26 **Belt conveyor idlers** available in greaseable and factory - sealed types for seven belt widths ranging from 14 to 36 in. are described in illustrated 6-p folder 2516. Link-Belt Co, 30 N Michigan Ave, Chicago 1, Ill.

27 **Sectional belt conveyors** in standardized, pre-engineered units with capacities ranging to 1500 tons per hr are described in 8-p bulletin 2579. Link-Belt Co, 307 N Michigan Ave, Chicago 1, Ill.

28 **Flyash intake valve** for use with pneumatic flyash conveyors is subject of illustrated 4-p bulletin 1-1-55. Describes application for manual and automatic operation. United Conveyor Corp, 407 S Dearborn St, Chicago 5, Ill.

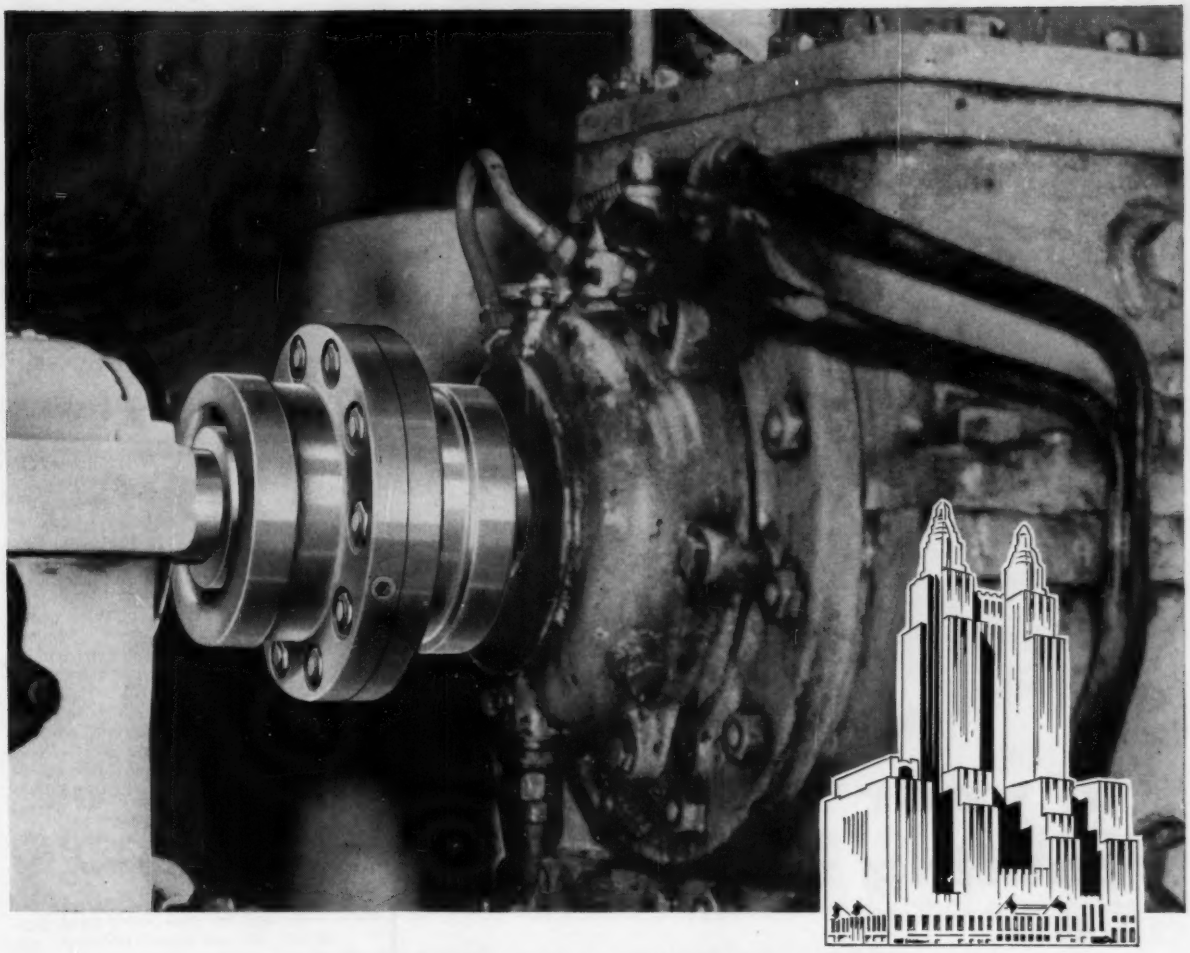
29 **Car pullers.** Illustrated 10-p bulletin L-6 illustrates and describes capstan - type units for moving cars a short distance using manila rope. Three styles of drum car pullers for heavy-duty moving, shuttle work or for servicing large areas are also listed. Clyde Iron Works, Inc, Duluth 1, Minn.

MECHANICAL TRANSMISSION

30 **Variable speed reducer** catalog describes principles of operation of units with output speeds from true zero to ¼ input speed. Contains 12-pp that detail operation principles, performance, construction, applications, dimensions and ratings. Revco Inc, 2 E Franklin Ave, Minneapolis 4, Minn.

31 **Speed reducers.** Illustrated 52-p bulletin 450 contains hp rating tables, specs, dimensions, weights and other data needed for quick selection of speed reducers for various applications. Farrel-Birmingham Co, Inc, Ansonia, Conn.

32 **V-belt drives.** Origin, history and development of the modern multiple V-belt drive is discussed in illustrated 36-p pocket-size bul-



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More FREE LITERATURE

Begins on page 171

letin 20E8297. Tells how to engineer a V-belt drive; provides tables and data; describes modifications in V-belt drives. Allis-Chalmers Mfg Co, 952 S 70th St, Milwaukee, Wis.

33 **"Reduce speed"** is title of illustrated 8-p bulletin E-2408. Discusses line of gearmotors available with new NEMA motors and redesigned gearheads. Reliance Electric & Engineering Co, 1088 Ivanhoe Rd, Cleveland 10, Ohio.

METALS AND ALLOYS

34 **Alloy** and stainless steels for the process and manufacturing industries are discussed in illustrated 102-p catalog 175-A. Includes corrosion-resistant data, chemical composition, representative mechanical properties of corrosion-resistant, heat-resistant, impact- and abrasion-resistant alloy steels. Electric Steel Foundry Co, 2141 NW 25th Ave, Portland, Ore.

35 **"Special steels** for industry" is title of 16-p bulletin. Gives details as to stainless steels, electrical materials, *Carmet* carbide materials and tool steels. Includes charts giving analysis of various steels. Allegheny Ludlum Steel Corp, 2020 Oliver Bldg, Pittsburgh 22, Pa.

PIPING, VALVES, FITTINGS

36 **Pvc pipe fittings** and flanges are described in illustrated 12-p bulletin. Shows characteristics, advantages and limitations; lists operating pressures, temperatures, applications, dimensions, weights. Grinnell Co, Inc, 260 W Exchange St, Providence 1, R. I.

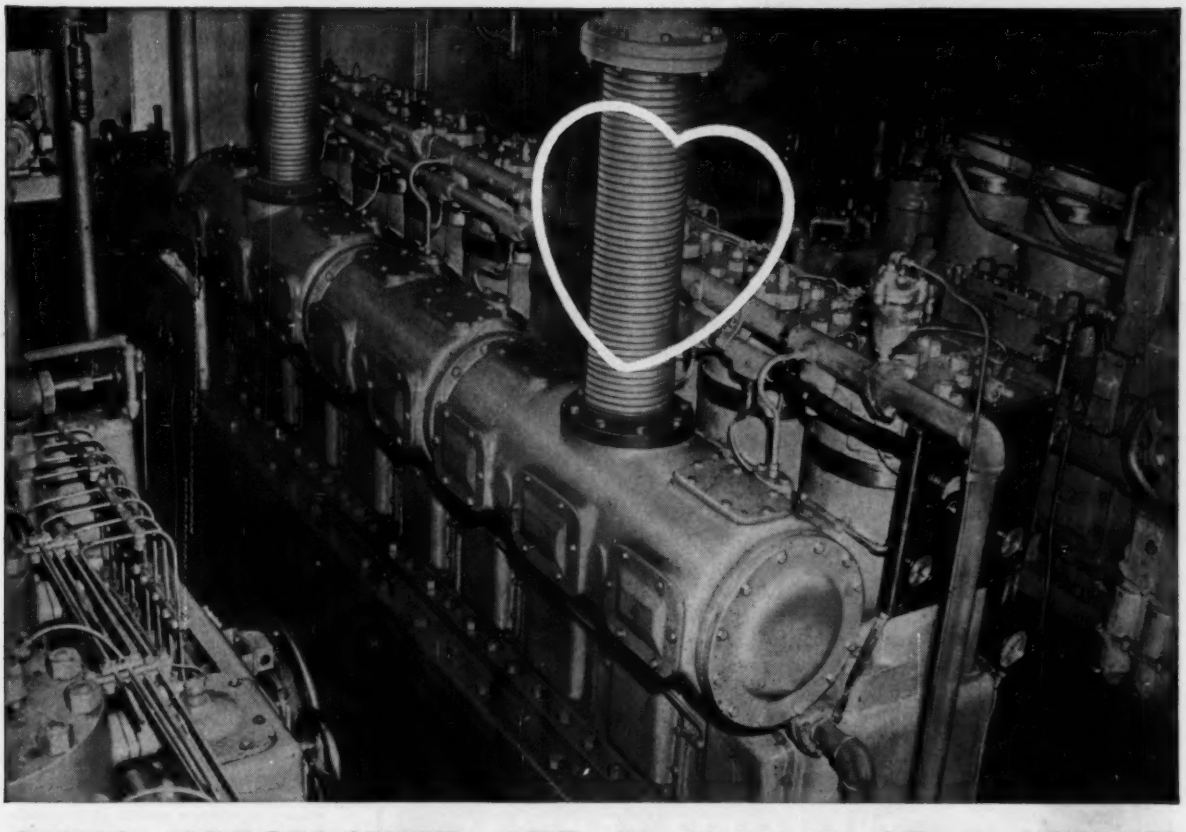
37 **Expansion joints.** Illustrated 24-p catalog 53 gives construction details, specs, application data for various piping systems. Cook Electric Co, 2700 N Southport Ave, Chicago 14, Ill.

38 **Pipe and block** insulation made of hydrous calcium silicate is suitable for hot outdoor piping and process equipment operating at service temperatures to 1200 F. Illustrated 12-p bulletin IN-169A. Johns-Manville, 22 E 40th St, New York 16, N. Y.

39 **Pipe insulation** can be applied to copper tubing and iron pipe; will withstand temperatures as low as 32 F, as high as 200 F. Two-page bulletin contains info on features, physical and thermal characteristics. Armstrong Cork Co, Lancaster, Pa.

40 **Reducing valves.** Direct-operated water-pressure units are described in illustrated 4-p bulletin 1009. Contains cutaway view, capacity charts, typical applications. Spence Engineering Co, Inc, Walden, N. Y.

41 **Air control valves.** Illustrated 4-p bulletin serves as a quick-reference guide to 17 different



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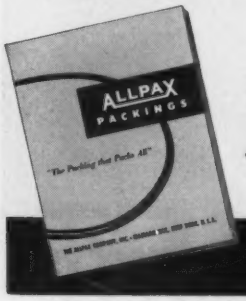

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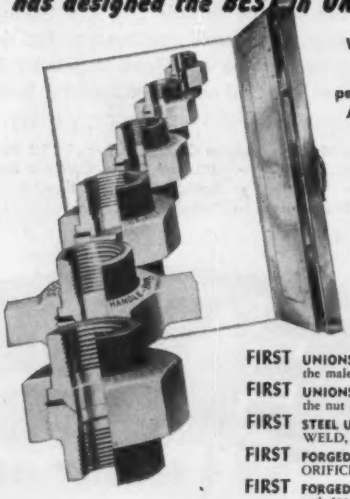

Way back in 1912 Clayton Mark & Company realized industry's great need for a steel union capable of withstanding high temperatures, high pressure and severe wrench abuse.

A sturdy union that would again and again make and break with ease and still perform dependably in service.

They also realized that a door to the pipeline which could be opened quickly and closed tightly would become an important factor in reducing production losses and maintenance costs. This pioneering has brought about many Mark Firsts in steel union products.

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More FREE LITERATURE

Begins on page 171

lines of air-control valves and accessories. Airmatic Valve, Inc, 7317 Associate Ave, Cleveland 9, Ohio.

PUMPS

42 **Pumps** for medium- and high-head services are described and illustrated in 8-p bulletin A-155. Cross-sections of design are shown for bottom- and side-suction types. C H Wheeler Mfg Co, 19th and Lehigh Ave, Philadelphia, Pa.

43 **Canned motor pumps.** Illustrated 4-p bulletin 1030 describes *Series S* sealless centrifugal pumps. Performance curves, dimension drawings, operating principles and full specs are included. Chempump Corp, Station K., 1300 E Mermaid Lane, Philadelphia 18, Pa.

44 **Fire pumps.** Illustrated 36-p bulletin B-1500 contains 6-pp of selection charts and a set of typical fire pump specifications. Lists over 120 UL approved units. Peerless Pump Division, Food Machinery and Chemical Corp, 301 West Avenue 26, Los Angeles 31, Calif.

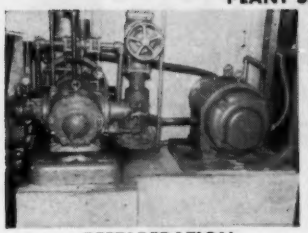
45 **Condensate** and vacuum pumps are described in illustrated 28-p bulletin 1465. Contains cutaway views, selection guide and installation diagrams. Sarco Co, Inc, Dept P, Empire State Bldg, New York 1, N. Y.

46 **Turbine-type pumps.** Illustrated 8-p bulletin 111 shows assembled and exploded views of units. Contains construction specs for pump parts requiring corrosion-resisting alloys. Aurora Pump Division of The New York Air Brake Co. Aurora, Ill.

"The Submersible Story" is title of film announced by Byron Jackson—said to be first complete factual story of the submersible pump. The submersible's progress from early designs to present day applications and installations is shown. This film may be obtained for showing by writing Roger Barron, Submersible Products Mgr, Byron Jackson Pumps, P.O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

"Well Jones, how's your first day in the battery room going?"

PLANT SERVICES



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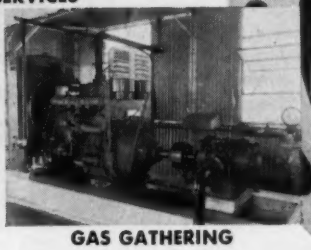
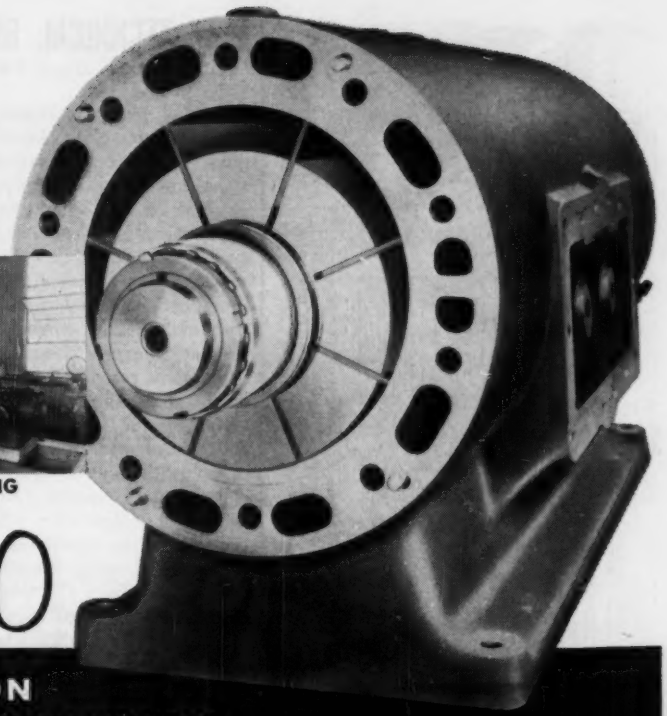


GAS GATHERING



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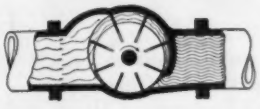

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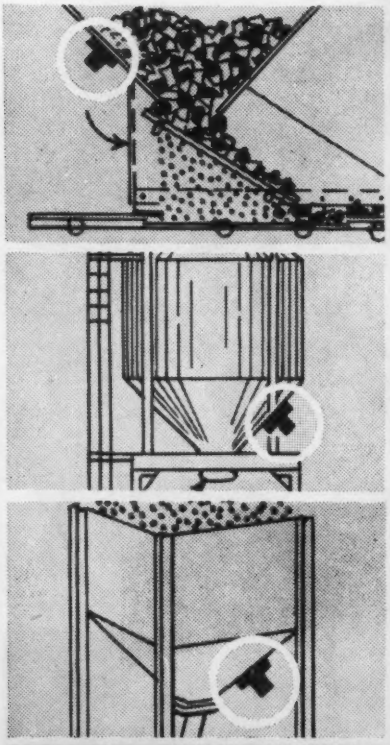

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More TECHNICAL BRIEFS

Begins on page 158

variety of problems relating to equipment design, plant layout, types of fuels, manpower utilization and other management items. Limited statistical value of the term operating availability is discussed, and the concept of relative mechanical availability is introduced.

Increasing technical and physical complications, together with larger unit sizes and greatly expanded generating systems, suggests the need for redistribution of responsibilities at the plant level. This has created a demand for higher grade engineering graduates with academic qualifications more suited to the special problems of thermal power production. Also, a larger degree of cooperative effort between utilities and universities appears desirable. *ASME paper No. 55-A-87.*

Maintenance control in steam power plants. *By G V Williamson, Union Electric Company of Missouri.*

The author's company has studied maintenance from both the engineering and accounting aspects, including a 10-year program of detailed cost records for hundreds of individual items of equipment. Over-all economy, not dollar maintenance costs, is stressed.

It is concluded that maintenance-cost reductions in the field of design are limited by development of suitable materials and by economic considerations, and in actual maintenance by economics and human attitudes.

Controlling some of these factors may be an exact science, but not those of human relationships, which are so complex that they are not subject to set rules. This makes maintenance cost a challenge in the field of applied psychology, as well as engineering. *ASME paper No. 55-A-174.*

Piping

The effect of the earth's rotation on laminar flow in pipes. *By G S Benton, The Johns Hopkins University.*

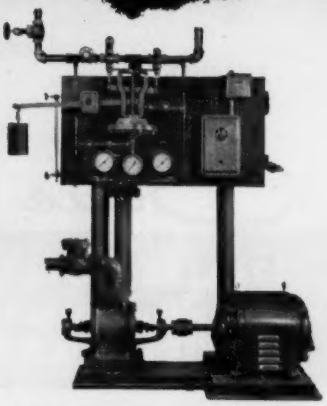
This paper develops the theory of laminar pipe flow, retaining the effect of the earth's rotation. It shows that this effect depends on the component of the earth's rotation normal to the pipe, and is thus a maximum for flow in the east-west direction.

Weak secondary circulations form in the cross-sectional plane. Intensity of these circulations, expressed nondimensionally, is proportional to the ratio of the Reynolds number and the Rossby number. *ASME paper No. 55-A-9.*

(*Continued on page 226*)

Directions for ordering papers on p 234

Cut Steam Costs
with Stickle's differential drainage and boiler return system



A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. **Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.**
2. **Raises production with higher, more uniform boiler pressure, higher temperature steam.**
3. **Reduces use of raw make-up water 85% to 90%.**
4. **Cuts maintenance on boilers, steam lines, traps and valves.**
5. **Improves quality by permitting operation of processing units at peak efficiency.**
6. **Cuts power used for pumping up to 75%, since system requires only 25 lbs.**
7. **Automatically maintains positive circulation without steam loss.**
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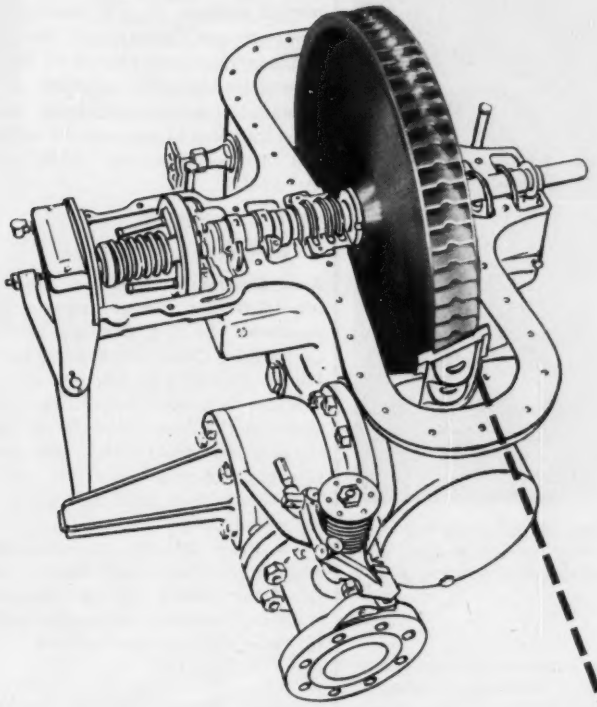
Work Horse of Industry..since 1906



The Terry Steam Turbine Company was incorporated in 1906 to manufacture *a workable and efficient prime mover that would operate with minimum maintenance.* This prime mover was the solid-wheel turbine, which had been invented by Edward Clinton Terry a few years before.

Although maintenance practice has improved vastly since then, the demand for the turbine has multiplied many times. *Rising maintenance costs have actually increased the need for trouble-free operation.*

Today, there are more Terry solid-wheel turbines in operation, and there are more built each year, than ever before. The explanation is simple.

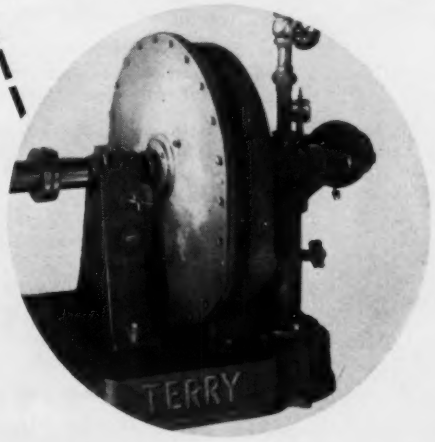
Here is a turbine with a virtually indestructible wheel. Made of a single forging of special composition steel, there are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which may occur does not materially affect horsepower or efficiency.

Blades will not foul. They have large clearances and are further protected by the projecting rims at the sides of the wheel. As the side clearances are also very large, end play can do no harm.

These are a few of the reasons why the Terry solid wheel turbine has been the *work horse of industry — since 1906.* For the full story, send for a copy of Bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

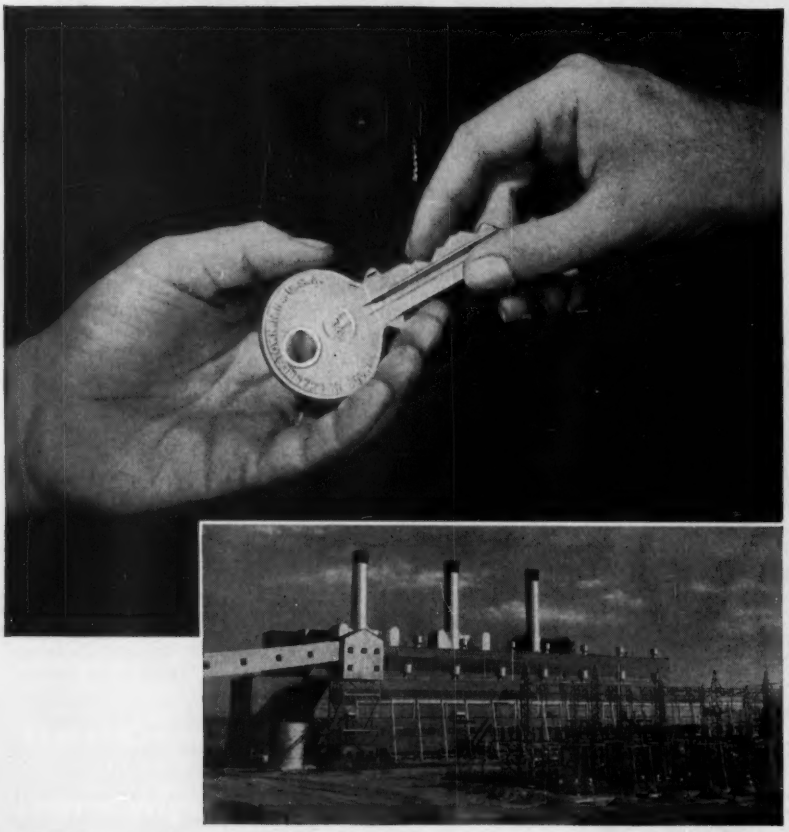
TERRY



1906 was the year this turbine was built in Terry's plant. It is believed to be one of the first small direct-connected turbines built for commercial use in the United States.

TT-1203

WHY A TURN-KEY PROJECT IS BEST FOR YOU



A Turn-Key project is a "packaged" service that combines engineering and construction in a single contract . . . and that may include other services such as preliminary investigations, studies and site selection, procurement of materials and equipment, initial operation of the finished plant.

Advantages to you:

LESS COST: Who is better qualified to construct a project than the firm that designs it? In a Turn-Key project one organization performs both engineering and construction services; details are handled quickly, efficiently—therefore more economically.

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We offer you engineering and construction services separately but suggest you consider combining them into a Turn-Key project that will save you both time and money. Write today for this free booklet describing the advantages in detail.

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More TECHNICAL BRIEFS

Begins on page 158

The solution of multiple-branch piping-flexibility problems by tensor analysis. *By J W Soule, United Engineers and Constructors, Inc.*

This paper presents a general method of flexibility analysis which, by use of tensors, makes it possible to derive performance equations of highly complex piping systems by a routine procedure. *ASME paper No. 55-A-83.*

Tensor-flexibility analysis of pipe-supporting systems. *By J W Soule, United Engineers and Constructors, Inc.*

A general tensor method of analysis is used to derive the equations of performance of a complete piping system. Includes effect of pipe weight, supports and thermal expansion. *ASME paper No. 55-A-82.*

Hydro

Water-hammer calculations and test results—Owens Gorge power plant penstocks. *By A E Bratfisch and K O Cartwright, Department of Water & Power, City of Los Angeles.*

Water-hammer calculations were made for the three penstocks of Owens Gorge power plants to determine proper governor and relief-valve time settings. Test results show good agreement with the calculations.

The paper includes computing methods, complete test results and an analysis of the results. A brief discussion of the operation of the surge chambers for these plants is also included. *ASME paper No. 55-A-71.*

Hydraulic-turbine runner vibration. *By R M Donaldson, Newport News Shipbuilding & Dry Dock Company.*

This paper describes an investigation of vibration characteristics of Francis turbine runners and some experiments to determine the influence of different shapes of runner-bucket discharge edges on the excitation forces. Modifications suggested by the experiments were made to field runners and were successful in eliminating some objectionable vibration. *ASME paper No. 55-A-130.*

Field-testing a reversible pump-turbine. *By Frank E Jaski, Allis-Chalmers Manufacturing Company.*

An efficiency test of the reversible pump-turbine at Flatiron Power and Pumping Plant, Bureau of Reclamation, was made in June, 1954, with flow measurements by the salt-velocity method. This is the first reversible

Directions for ordering papers on p 234

MIGHTY . . . SAFE!

Navy adopts Cellulube* fire resistant hydraulic fluids to safeguard aircraft elevator systems

To minimize danger from fires and explosions that might hamper the operational efficiency of its great carriers, the U. S. Navy is now using Celanese* Cellulube 220, a straight chemical compound, as hydraulic fluid to activate deck-edge elevators.

Used for more than 1,500 hours aboard the Bennington, Shangri-La and Ticonderoga, Cellulube 220 is in service aboard the new Saratoga, and is also being evaluated for additional Naval applications.

Cellulube 220 is one of a series of synthetic (non-petroleum) functional fluids developed for industry by Celanese in six controlled viscosities. These fire-resistant hydraulic fluids and cylinder lubricants provide a significant margin of safety wherever high temperatures and pressures may cause fire or explosion.

For additional information about the Celanese Cellulube series, write to Celanese Corporation of America, Chemical Division, Department 597-D, 180 Madison Avenue, New York 16.

In Canada, Canadian Chemical Company, Ltd., Montreal, Toronto, Vancouver.

DECK EDGE ELEVATOR TAKES PLANE TOPSIDE. Cellulube 220 is being used in elevators of this type on the Shangri-La, Bennington and Ticonderoga. The Navy plans to install fire-resistant hydraulic fluids on all carriers.

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This "master regulator" incorporates a compensating device which assures accurate pressure regulation without hunting or over-shooting. Used with CFE Lectricarm, automatic proportioning provides highest combustion efficiency. Steam pressure is maintained at a constant level despite varying loads. Responsive to pressure changes within 1% of pressure setting. For use with single or multiple boiler installations.

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More TECHNICAL BRIEFS

Begins on page 158

pump-turbine designed, built and installed in the U.S.

The paper describes the unit and method of performing the tests. Today the unit is operating satisfactorily both as a pump and a turbine. During 21 months of operation the importance of careful performance tests has become apparent. *ASME paper No. 55-A-29.*

Operation of large synchronous generators in the dynamic stability region with a modern amplidyne voltage regulator. Part I: Recommendations for setting the underexcited reactive ampere limit. Part II: Operating tests and analytical studies. *By K R McClymont and P L Dandeno, Hydro-Electric Power Commission of Ontario, and R A Phillips and A S Rubenstein, General Electric Company. AIEE papers Nos. 56-137 and 56-138.*

Reactor construction

Reactor shielding. *By E P Blizzard, Oak Ridge National Laboratory.*

Problems attendant upon shielding of reactors are described briefly. Sources of radiation and their relative importance are enumerated. The interaction processes for gamma rays and neutrons are described; some discussion is given of their relative importance. Need for thermal shields in a reactor is detailed. Common biological shield materials are enumerated with their relative advantages and disadvantages. Some current shield designs are illustrated. *NESC paper No. 11.*

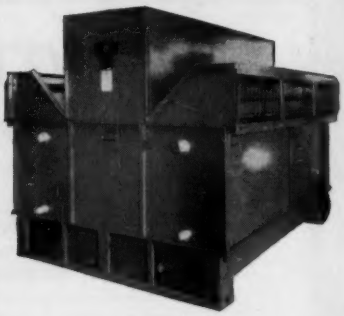
Safety aspects of water-cooled and moderated reactors. *By R J Creegan, Westinghouse Electric Corp.*

The negative temperature coefficient and the expulsion of moderator are listed as major safety aspects of water-cooled reactors. The fuel, clad, pressure vessel and vapor container multiple confinement of fission fragments makes improbable the danger to surrounding areas due to distribution of fission fragments. The start-up, cold water, and loss of coolant incidents are described with possible results. The means of preventing or minimizing the accidents are listed. The effect of temperature inversions on fission fragment dispersal is also described. *NESC paper No. 10.*

Proposed structural design basis for nuclear reactor pressure vessels. *By W E Cooper, General Electric Co.*

Purpose of a structural design basis

Directions for ordering papers on p 234



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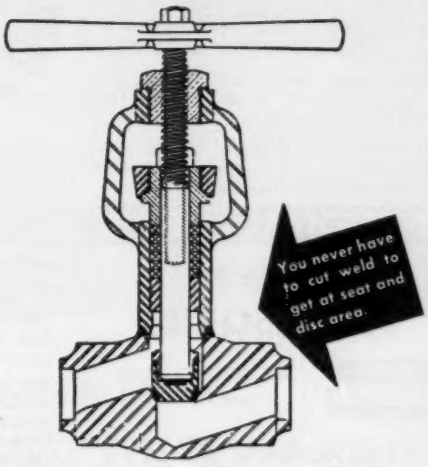

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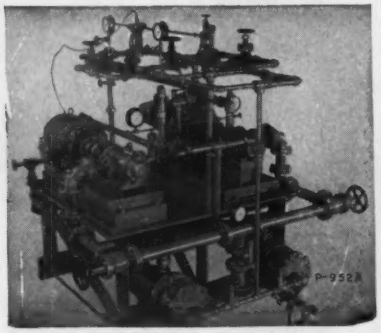

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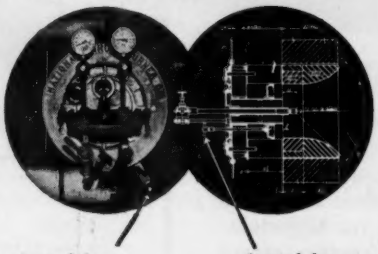

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More TECHNICAL BRIEFS

Begins on page 158

is to provide design guidance toward ensuring structural reliability of a component. Functional requirements for nuclear reactor pressure vessels are discussed and a structural design basis is proposed. A new basis is considered necessary because of the lack of applicability of present industrial codes —particularly if higher strength materials are to be applied. Essential features of the proposed basis are the limitation of maximum shear stresses so as to prevent gross deformations and fatigue fracture and recognition of the differing structural significance of the various types of imposed loads. *NESC paper No. 8.*

Safeguard features of a fast breeder reactor power plant. *By Walter J McCarthy Jr, Atomic Power Development Associates, Inc, and Francis C McMath, The Detroit Edison Co.*

In the design of a reactor power plant, special attention to safety is required in order to safeguard the investment in the plant and to ensure that danger to the public is reduced to negligible proportions. Some design features relevant to the safety of a fast breeder reactor power plant are described. Decision to enclose radioactive portions of the plant in a gas-tight building to provide a final barrier between the reactor and the public is discussed. Criteria developed for locating the reactor on a safe and economically suitable site are presented. *NESC paper No. 4.*

Controls

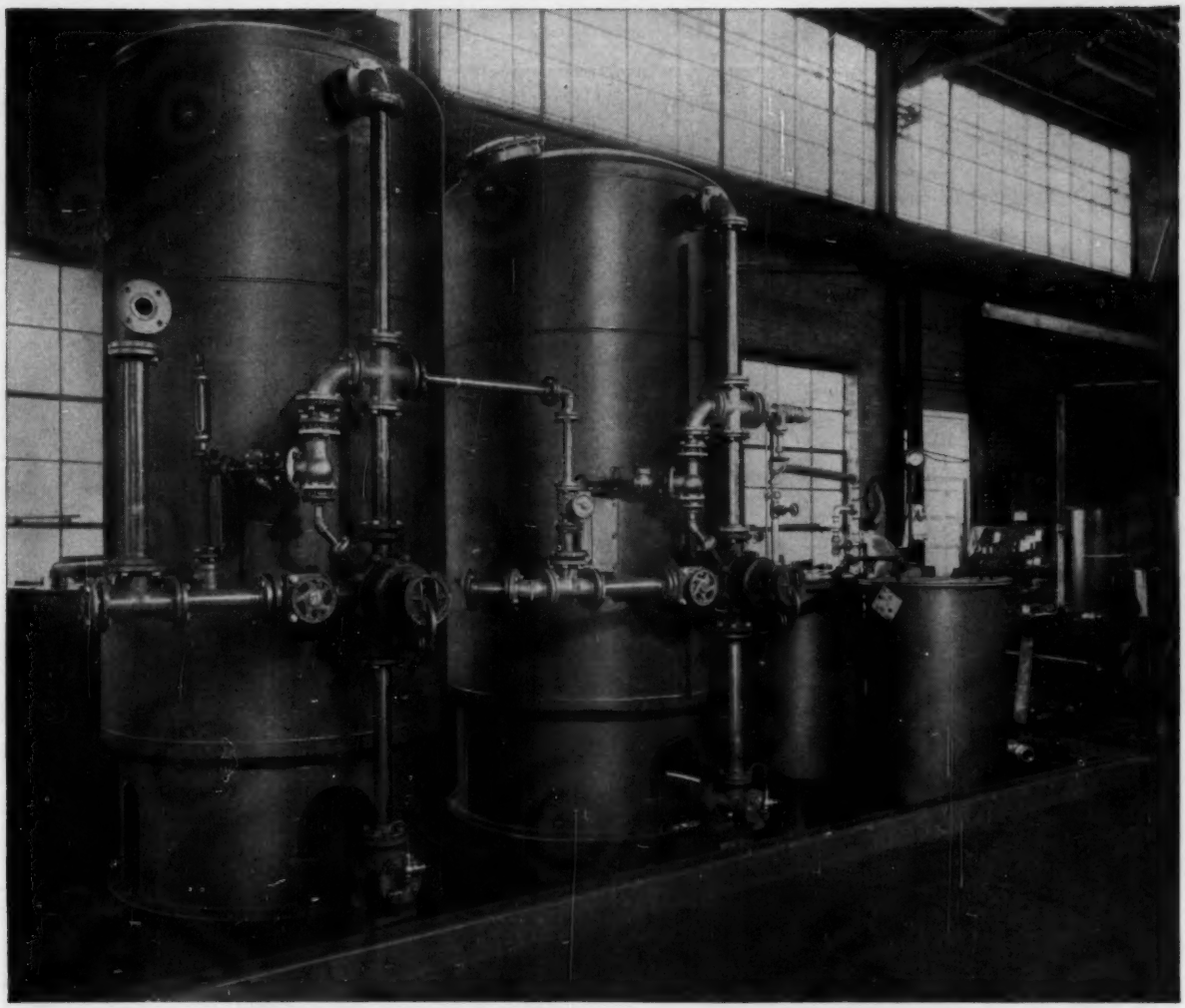
Hydraulic nuclear reactor controls. *By Michael Silverberg, Engineering Research and Development Laboratories.*

This paper describes applications where hydraulic nuclear reactor controls can be employed to advantage. Several types of systems are discussed with emphasis on the question of the desirability of feedback. A general treatment of basic design criteria is followed by a description of a suggested system, both functionally and from viewpoint of component selection. *NESC paper No. 27.*

Dynamics and control of nuclear power plants. *By A B Van Rennes, J C Simons Jr, and T S Gray, Massachusetts Institute of Technology.*

After a description of a philosophy of control, a study is made of the steady-state energy flow pattern as well as of the dynamic behavior in a nuclear power plant. Major burden of control is

Directions for ordering papers on p 234



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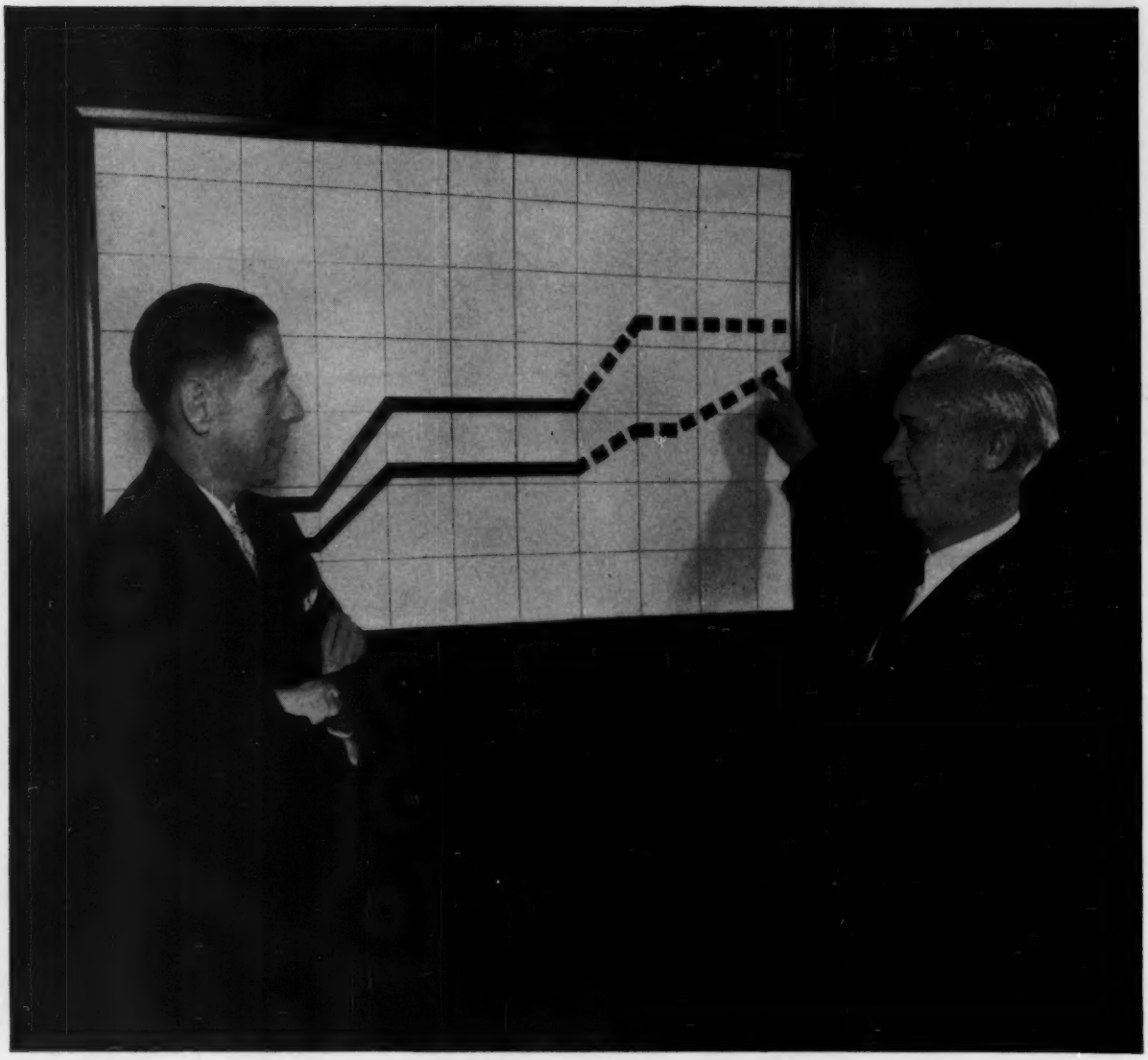

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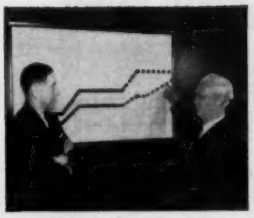

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Begins on page 158

placed upon the stabilizing effect of a negative temperature coefficient of reactivity. The dynamic analysis of the plant is presented from the viewpoint of a feedback-control engineer. It provides expressions for significant plant variables in response to changes in reactivity, temperature and load power. *NESC paper No. 26.*

Problems of production reactor instrumentation. *By Thomas R Vick Roy, E I duPont deNemours and Company.*

Some problems encountered in production reactor instrumentation are discussed. Four examples are presented: monitoring flow in reactor cooling channels; monitoring temperature in the same channels; measuring the relative motion of reactor parts due to thermal expansion; and control of liquid level in a tank. *NESC paper No. 22.*

Heat transfer

Liquid bismuth as a fuel solvent and heat transport medium for nuclear reactors. *By O E Dwyer, D H Gurinsky, and J R Weeks, Brookhaven National Laboratory.*

Chief purposes of this paper are to discuss qualifications of liquid bismuth as a heat transfer medium in nuclear power reactors and to show how its characteristic influence design and operation of reactor systems. Much of the information presented was obtained at the Brookhaven National Laboratory in connection with the development of the liquid metal fuel reactor—a thermal power breeder reactor for central-power station applications. Included is a discussion of such factors as pumping-power requirements, metallurgical problems, heat transfer, radioactivity, chemical reactivity and nuclear considerations. In treating some of these topics, bismuth is compared with other, typical reactor coolants. *NESC paper No. 50.*

Hydraulic analysis of sudden flow changes in a complex pumping circuit. *By George E Alves, E I duPont de-Nemours and Co.*

A problem arose as to what would happen if there were sudden failures of power to one or more pumps of a large-scale complex pumping circuit composed of several individual pumping systems.

This paper describes the application of several published methods of hydraulic transient analysis to the problem. The performance of the system computed under several assumptions is dis-

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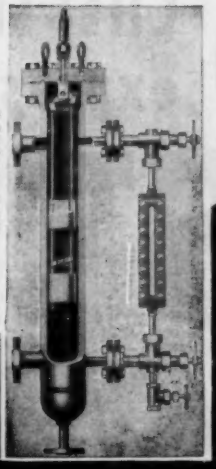

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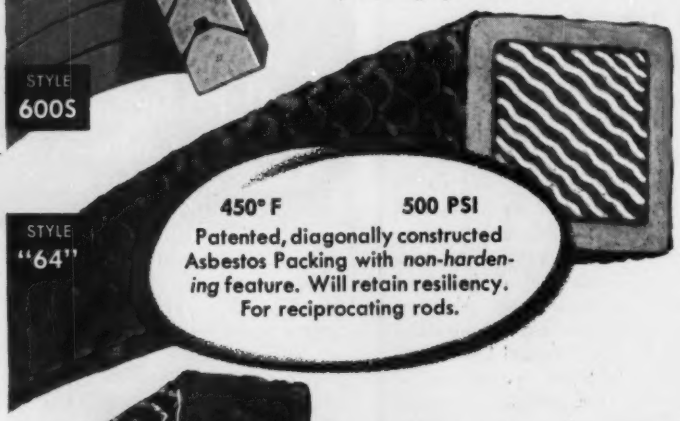

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Begins on page 158

cussed and a comparison is made with experimentally determined values.

Results of this study would be of interest to those who may be confronted with similar problems. *NESC paper No. 56.*

Effects of coolant-flow orificing and monitoring on safe pile power. *By Michael Markels Jr, Columbia Univ.*

General heat transfer characteristics of a liquid-cooled, multi-channeled reactor are introduced along with the most important types of malfunction that might be expected. Effect of inlet orificing on flow instability is detailed and important factors for the case of local boiling burnout are introduced. Temperature and pressure monitoring of the coolant flow are discussed and monitor trip equations are derived. Orifice and monitor approach to maximum safe pile power are contrasted, showing the orifice to be limited in scope but surer in operation, while the monitor is wider in scope but inherently less reliable. *NESC paper No. 57.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from sources, not POWER.

American Society of Mechanical Engineers. Identified by initiols ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

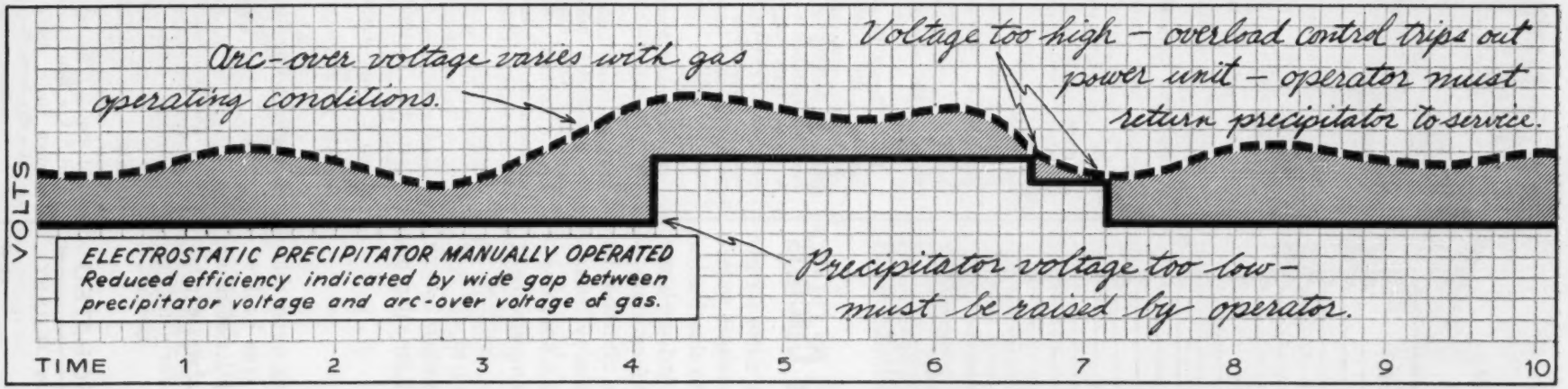
American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

Papers identified by initials NESC, Nuclear Engineering and Science Congress, are obtainable at 30c each from the American Society of Chemical Engineers, 25 W 45th St, New York 36, N. Y.

First National New Products, New Methods and Patents exposition will be held in Detroit in the fall of 1956 under the combined sponsorship of civic, management and labor organizations in cooperation with private industry and state, municipal and federal government agencies.

An agreement for the design, procurement and construction of a $130,000,000 steel plant expansion at Jamshedpur, India has been signed between The Tata Iron and Steel Co, Ltd, and Kaiser Engineers Division of Henry J Kaiser Co.

EFFICIENCY GRAPHS: Comparative graphs show the relative difference between MANUAL and AUTOMATIC power operation for electrostatic precipitators


Arc-over voltage varies with gas operating conditions.
Voltage too high – overload control trips out power unit – operator must return precipitator to service.
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Reduced efficiency indicated by wide gap between precipitator voltage and arc-over voltage of gas.
Precipitator voltage too low – must be raised by operator.
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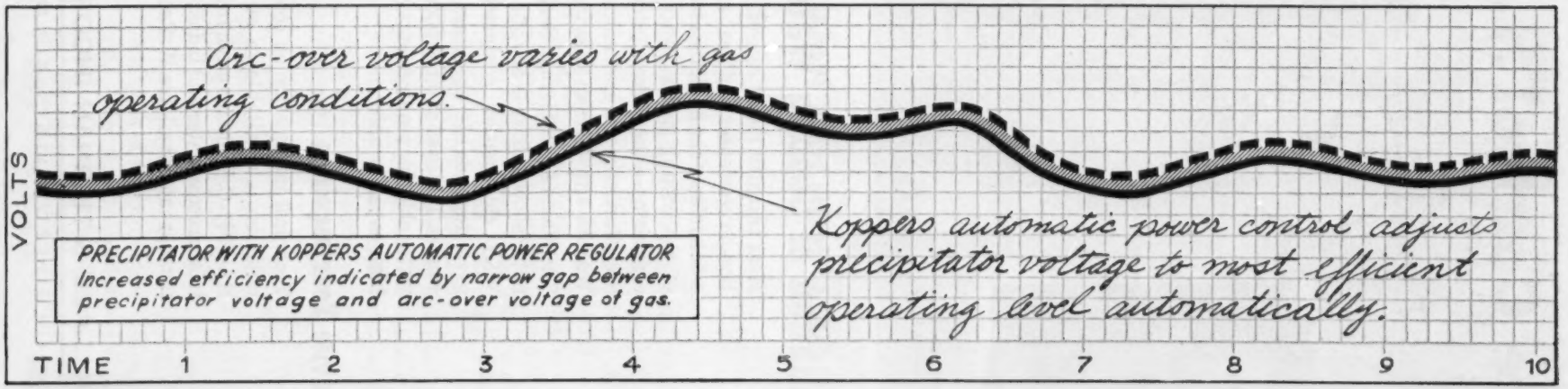
Arc-over voltage varies with gas operating conditions.
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Increased efficiency indicated by narrow gap between precipitator voltage and arc-over voltage of gas.
Koppers automatic power control adjusts precipitator voltage to most efficient operating level automatically.
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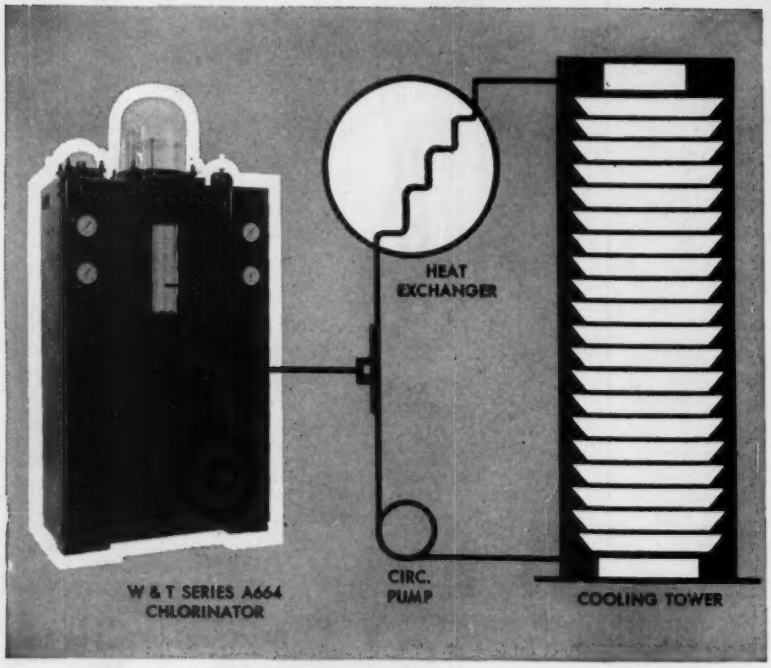

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APPOINTMENTS

Cloud Wampler

William Bynum

Corporation executive changes

Carrier Corp: Cloud Wampler, chairman of the board; William Bynum, president. **Arthur D. Little, Inc:** Earl P Stevenson, chairman of the board; Raymond Stevens, president; Richard J Coveney, vice-president. **Walter Kidde Nuclear Laboratories, Inc:** Wilbur E Kelley, president. **American Radiator & Standard Sanitary Corp:** Elbert M Palmer, president of the Kewanee boiler division. **The Wellman Engineering Co:** Robert C McDowell, president.

I-T-E Circuit Breaker Co: William Deans, vice-president; G E Heberlein, vice-president, engineering; L H Lipscomb, vice-president, sales. **Copeland Refrigeration Corp:** W G von Meyer and Rudy Berg, vice-presidents. **Rockbestos Products Corp:** Paul W Becker, vice-president, manufacturing. **Weston Electrical Instrument Corp:** Samuel J Childs, vice-president and general manager.

Vitro Corp of America: Frank B Jewett Jr, vice-president. **The Bird-Archer Co:** C W Bird Jr, vice-president. **Rockland Light and Power Co:** Vernon M F Tallman, vice-president. **The Rust Engineering Co:** Henry C Goodrich, vice-president. **The Maintenance Co, Inc:** William J Wheeler Jr, vice-president; Richard M Wheeler, director.

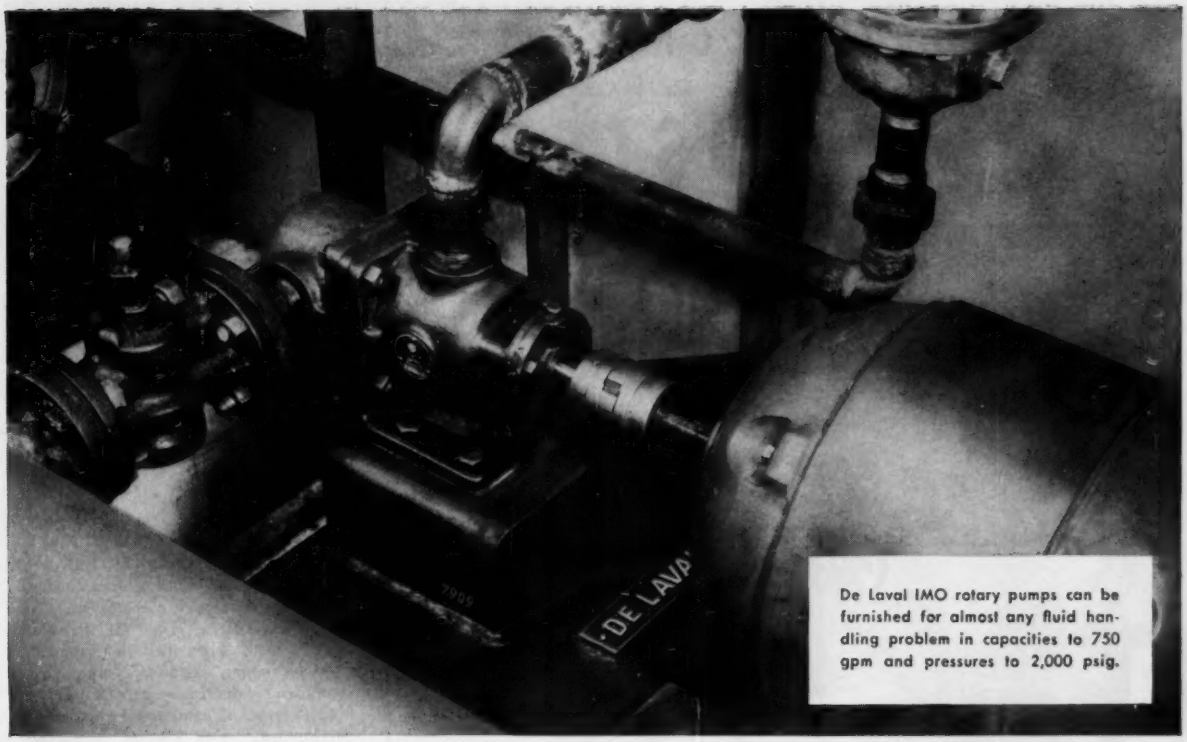
Colonial Iron Works Co: W J Hegerty, vice-president. **Burndy Engineering Co, Inc:** Julian Rogoff, vice-president. **Horizons Inc:** John T Burwell Jr, vice-president. **Norton Co:** Edwin C Evans, director; Howard J Daly, vice-president, in charge of crude abrasive plants.

Operations executive changes

The Permutit Co: Charles Bueltman, manager, industrial waste treatment dept. **Downingtown Iron Works, Inc:** W L Killen, general manager. **Robertshaw-Fulton Controls Co:** Wilbur Jackson, general manager of Grayson controls division; Robert L Wehrli, general manager of aeronautical division. **General Electric Co:** Karl R Van Tassel, manager of atomic products study, atomic products div.

Alco Products, Inc: C S Seabring,

(*Continued on page* 238)



De Laval IMO rotary pumps can be furnished for almost any fluid handling problem in capacities to 750 gpm and pressures to 2,000 psig.

What to Look for in a Rotary Screw Type Pump

By W. J. MONCON, *Assistant Chief Engineer*
De Laval Steam Turbine Company

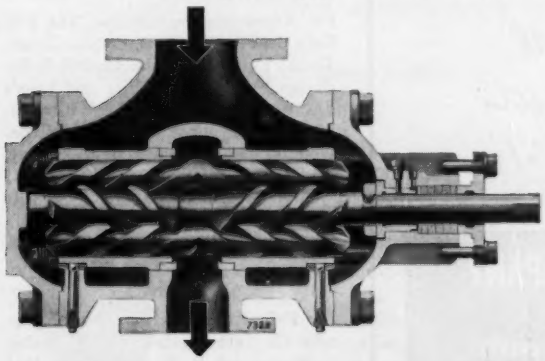
A sound knowledge of design, and how it affects performance, is the best insurance a buyer can have that he will get the pump he needs. This brief analysis of the IMO, a rotary three-screw pump manufactured by the De Laval Steam Turbine Company, will give you some of the necessary facts.

What qualities should you look for in a rotary type pump? It must, of course, meet specified capacities and pressures. But, it must also be efficient, operate quietly, stay on the job.

The axial flow of a screw type pump, and the resulting low inlet losses for any given pump speed, are important benefits that should be considered in making pump selections. The absence of timing gears and other mechanical features of construction also enable the De Laval IMO pump to operate at direct-connected motor and turbine speeds . . . to handle viscous liquids and high suction lifts.

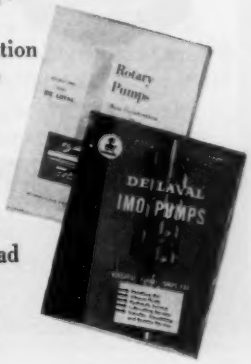
One of the most important features of the IMO pump is the hydraulic turning of the idler or sealing rotors. The central or power rotor is the pumping element; the liquid pumped turns the sealing rotors.

A screw type pump is well suited for applications where pulsation-free flow is desirable. The axial flow of the liquid without trapping and the unique thread form which keeps closures fluid-tight contribute to quiet operation of the IMO pump.



This is a cross-section of the De Laval IMO Series A322A, a positive displacement rotary screw type pump.

Catalog LS gives useful application and specification data on the IMO pump. An article titled, *Rotary Pumps, Basic Considerations in Their Application*, contains a description of rotary pumps in general. For these publications, write on your company letterhead to De Laval Steam Turbine Company, 815 Nottingham Way, Trenton 2, New Jersey. DL-301



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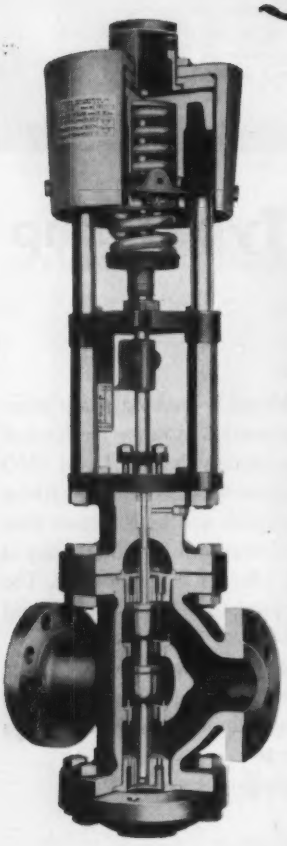
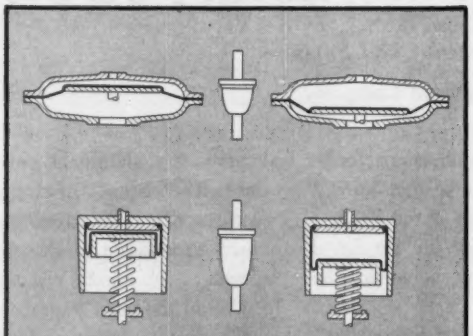
ISOFORCE ACTUATOR

Gives you greater sensitivity



. . . because the Foster Bellofram construction gives you longer travel than other diaphragm actuated types — allowing for increase in length of main valve for more sensitive throttling action.



These new control valves are available in sizes starting at ½" with materials and end connections to suit operating conditions.

For complete technical information, ask for Bulletin CV-1

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE, UNION, N. J.

- AUTOMATIC VALVES
- CONTROL VALVES
- SAFETY VALVES
- FLOW TUBES

More APPOINTMENTS

Begins on page 236

director of research and development. **Westinghouse Electric Corp:** F D Weatherholt, manager of gearing division. **Elgin Softener Corp:** Ben F Willey, director of technical information. **Baltimore and Ohio Railroad Co:** Eugene J Kerr, manager, technical development. **American Air Filter Co, Inc:** George C Rodgers, manager of engine and compressor dept. **I-T-E Circuit Breaker Co:** F G Schmidt, manager of switchgear division; William P Bolger, manager of small circuit breaker division.

Engineer changes

Worthington Corp: Robert S Sherwood, manager of engineering at steam turbine division, Wellsville, N. Y. **Hays Corp:** Frederick M Rutledge, chief control engineer; Crayton H Schwestka, chief design engineer. **The Trane Co:** R G Miner Jr, head of controls and electrical development; E T Neubauer, head of reciprocating compressor development; A M G Moody, head of centrifugal compressor development. **The United Manufacturing Co:** E Walter Hammer Jr, chief engineer. **Western Precipitation Corp:** H H Haaland, chief engineer, precipitator engineering division.

New sales managers

Hagan Corp: John E Duesing, mechanical division. **D J Murray Manufacturing Co:** L L Duncan, unit heater and mill supply division. **Morse Chain Co:** Raymond H Whitney, Southeastern district manager. **Link-Belt Co:** Donald L Shirley, Pacific Northwest territory. **Midwest Piping Co, Inc:** Phil R Becker, general sales manager.

The J S Coffin Jr Co: Raymond A Bocksel, marine and industrial sales and service. **White Motor Co:** J H Newton, White diesel engine division. **Raybestos-Manhattan, Inc:** Austin L Hawk, Western sales district (Chicago). **Ray-O-Vac Co:** Sidney J Ritchie, northeastern Ohio district.

New distributors

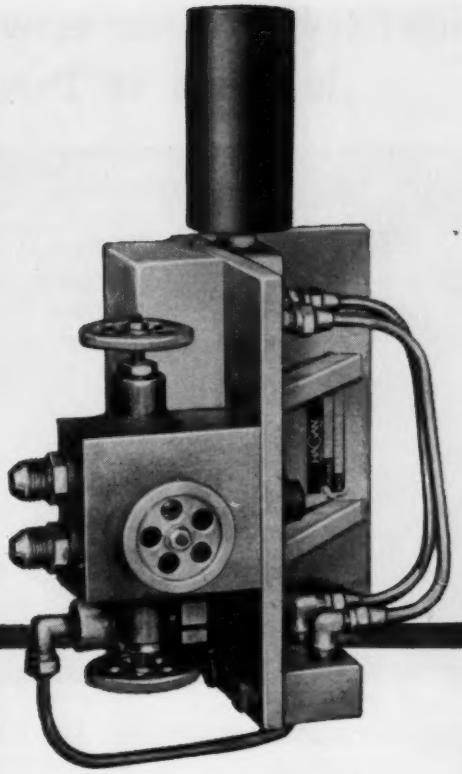
For **Automatic Switch Co:** The J K Kalb Co, P.O. Box 1003, Corpus Christi, Texas; Equipment Sales Co, 164 E Exchange St, Akron 4, Ohio; and Leen's Electric Motor Service, 54 Wilson St, Brewer, Me. For **Ampco Metal, Inc,** Weldrod dept: Miami Welding Supply, Inc, 3016 N Miami Ave, Miami, Fla.; Kaminis Welding Supplies, Inc, 3101 4th Ave, Tampa, Fla.; and Keenan Welding Supplies Co, Inc, Albany, Ga.

New representatives

For **Pyle National Co:** Atlas Equipment Co, 1416 Bigelow Ave, N, Seattle 9, Wash. and R W Spiedel, N 4604 Wall St, Spokane, Wash.; Applied Engineering Co, P.O. Box 506, Orange-

Accurate, measurement of pressure differentials up to 300 psi

HAGAN DELTA 'P' PRESSURE TRANSMITTER



The Hagan Delta 'P' Transmitter is a sturdy, compact, force-balance instrument for pneumatically transmitting large pressure difference measurements. Consider these features:

1. No stuffing boxes, torque tubes or pressure-tight bearings.
2. Not affected by static pressure changes.
3. Usable at any static pressures up to 3000 psig.
4. Full scale pressure difference measuring ranges from 50 psi to 300 psi with 1% full scale accuracy.
5. Shut-off and by-pass valves integral with instrument.
6. Not damaged by accidental application of full line pressure to either side of measuring element.
7. Stainless steel pressure elements, cadmium-plated steel frame.
8. Shock and vibration proof design.

A few Applications of the Delta 'P' Transmitter

Pneumatic signals from the transmitter are in the range of 0-30 psig, and may be used for indications and records, or for control of factors involved in such functions as:

Pressure difference between steam and boiler feedwater headers.

Steam pressure drop across superheater.

Pressure drop between boiler outlet and turbine throttle.

Pressure drop across high pressure heat exchangers.

Measuring pressure drop across liquid flow control valves for graduated control of pump discharge presssure.

As a "square root" flow meter when pressure differentials are higher than conventional flow meter design.

Measuring pressure differentials for alarm signal purposes under critical operating conditions, such as seal gas pressure during repair periods in a catalytic reformer unit.

HAGAN CORPORATION

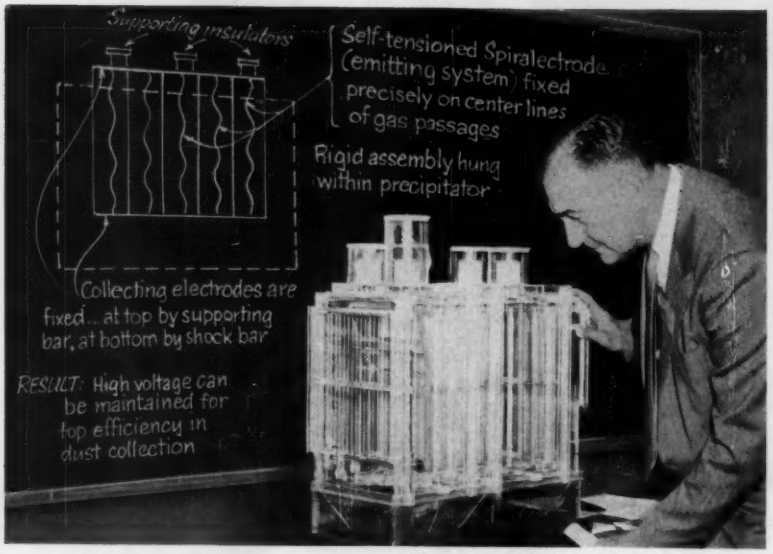
HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN

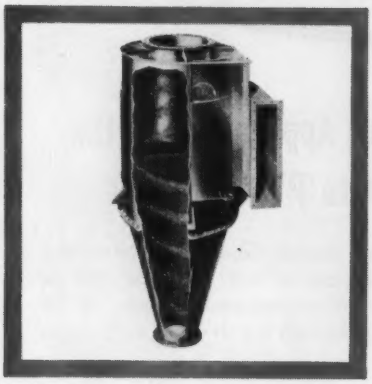
Systems and Components for: Boiler Combustion Control, Metallurgical Furnace Control, Process Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

HAGAN SUBSIDIARIES: CALGON, INC. • HALL LABORATORIES, INC.

How fixed electrodes assure top efficiency in a Buell "SF" Precipitator

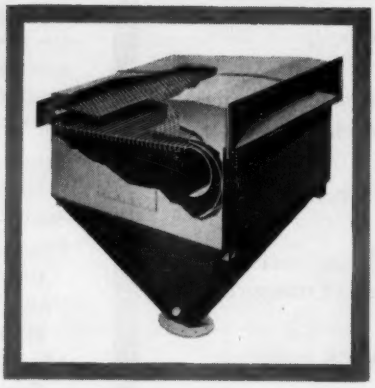

Supporting insulators
Self-tensioned Spiralelectrode (emitting system) fixed precisely on center lines of gas passages
Rigid assembly hung within precipitator
Collecting electrodes are fixed... at top by supporting bar, at bottom by shock bar
RESULT: High voltage can be maintained for top efficiency in dust collection

PHOTOGRAPH OF BUELL PLASTIC MODEL BY INDUSTRY & POWER



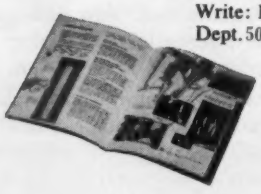
Even when high resistivity dusts must be collected, top efficiency is guaranteed by the exclusive shape of Buell's Spiralectrodes—proved to give 50-100% greater emission than straight wires. Exclusive Continuous Cycle Rapping virtually eliminates maintenance by keeping electrodes constantly clean.

Buell Cyclones also assure top efficiency with large diameter design to eliminate clogging . . . and by harnessing double-eddy and putting it to work.



Buell's Low Resistance Fly Ash Collector combines top efficiency to meet present strictness, with low draft loss for natural or mechanical installations.

GET ALL THE FACTS
Write: Buell Engineering Company,
Dept. 50-D, 70 Pine Street, New York 5, N. Y.



buell®

MECHANICAL ELECTRICAL

Experts at delivering Extra Efficiency in
DUST COLLECTION SYSTEMS

More APPOINTMENTS

Begins on page 236

burg, S. C. and 500 Piedmont St, NE, Atlanta, Ga. and P.O. Box 2311, Greensboro, N. C.; D B Gooch Associates, 5018 1st Ave, N, Birmingham, Ala. and Johnson Runey II & Associates, P.O. Box 26, 1136 Drew St, Clearwater, Fla.; O'Brien Specialty Co, Box 217, Eastwood Station, Syracuse 6, N. Y. and B M Conaty, 505 Crosby Bldg, Buffalo, N. Y.; John Allen Ware & Associates,

For **The New York Air Brake Co,** 301 W "G" St, San Diego 1, Calif. and P.O. Box 4216, Commerce Station, Phoenix, Ariz.

Hydreco and Dudco divisions: Elmer V Mrozek, 17-19 LaGrange Rd, LaGrange, Ill. For **Fuller Co:** Jobe & Co, 344 E 33rd St, Baltimore 18, Md. and 110 N 8th St, Richmond, Va. For **R P Adams Co, Inc:** R A Mueller and Associates, 920 E McMillan St, Cincinnati 6, Ohio and 961 Baxter, Louisville, Ky.

For **Morris Machine Works:** J E Kennard, Tampa, Fla. For **Automatic Temperature Control Co, Inc:** William B Parker Jr, 1915 N Harlem Ave, Chicago 35, Ill.

Recent purchases, mergers

Morse Chain Co: acquisition of Eberhart-Denver Co and its affiliate, the Spreco Co. **C H Sprague & Son Co:** purchase of Gulf Mining Co. **The Flori Pipe Co** will become a wholly-owned subsidiary of **Sparks-Withington Co.**

Institute elections

American Society of Heating and Air-Conditioning Engineers: John W James, president. **Convector Manufacturers Association:** J M Whalen, president; R S Rickabaugh, vice-president; R O'Rourke, secretary-treasurer.

Retirements

Harold N Hackett, a pioneer engineer in the construction of both atomic power facilities and the mercury-steam power plant, General Electric Co.

William R Moore, director and vice-president in charge of national accounts, Norton Company.

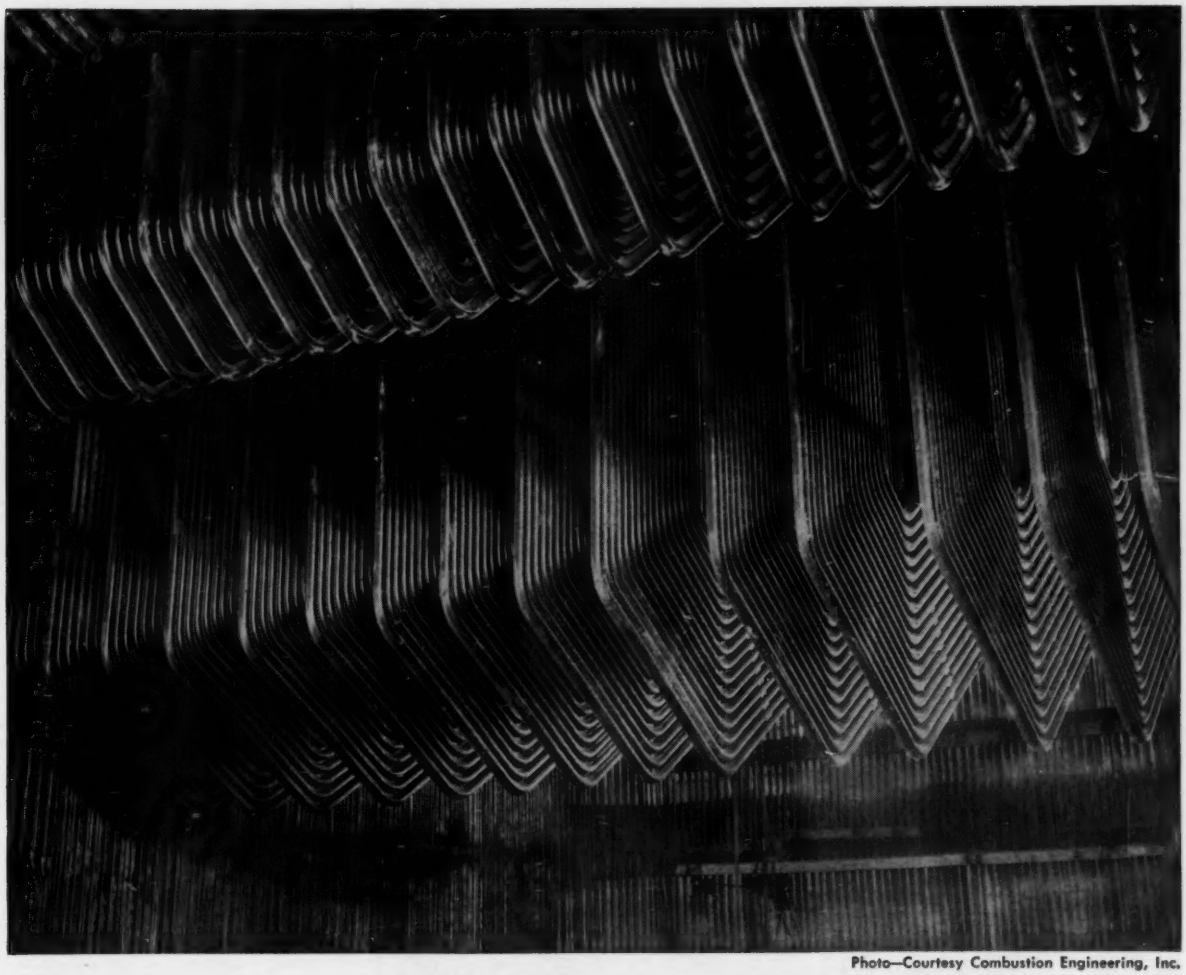
Obituaries

Joseph B Swering, engineering consultant of The Hartford Steam Boiler Inspection and Insurance Co, on January 17.

Rudolf Unfug, 65, architect-engineer for The Rust Engineering Co, on February 1.

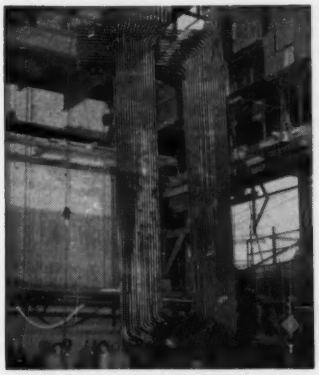
W M Reed, 63, founder and chairman of the board of American Air Filter Co, Inc, on February 2.

Raymond L Walsh, 65, retired assistant vice-president and chief engineer of Universal Atlas Cement Co, on February 23.



Photo—Courtesy Combustion Engineering, Inc.

49 Miles of NATIONAL SEAMLESS



One of the huge superheater coils being hoisted into position.

. . . make up this giant superheater. And it's only a small portion of the total tubing used in this huge modern boiler. Here, steam at more than 2000 psi is superheated to 1000F. Severe as this duty is, it poses no problem for *seamless* tubes which, in fact, have been built to withstand much higher pressures and temperatures.

USS NATIONAL Seamless Pipe and Tubes are chosen almost invariably by designers and power engineers for boilers and high-pressure steam lines. They specify National Seamless as they always have in the past—secure in the knowledge that NATIONAL promises long, safe, and satisfactory service.

Even under the severest operating conditions, NATIONAL Seamless Pipe and Tubes have never been excelled for safe, efficient power plant service. Pierced from solid billets of steel, they have the strength, uniformity, and dependability of solid forgings. Each length is an homogeneous steel cylinder with uniform wall strength throughout, designed to remain structurally sound under high temperatures and tremendous pressures.

For full details on the use of NATIONAL Seamless in power installations, write for Bulletins 10 and 26. Or, if you're planning an installation, and would like some help, let our engineers give you a hand.

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.

(Tubing Specialties)

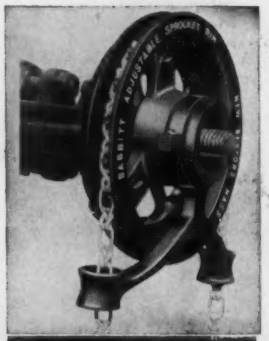
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS **NATIONAL Seamless PIPE AND TUBES**

WELDS WITHOUT WELDS

UNITED STATES STEEL

NEW! Re-Designed



Babbitt
Adjustable
SPROCKET RIM
with Chain Guide

ANY VALVE is readily accessible *from the floor* with low-cost Babbitt Sprocket Rim. Now re-designed for —

- **Greater strength**
- **Easier, quicker, more solid assembly**

Simplifies pipe layouts, prevents accidents, fits all valve wheels. Your supplier carries complete stocks. Call him — or write for folder and prices.

Babbitt STEAM SPECIALTY CO.
2 BABBITT SQ., NEW BEDFORD, MASS., U.S.A.

ERNST
HIGH PRESSURE GLASSES and GASKETS

All sizes to fit your gages and valves

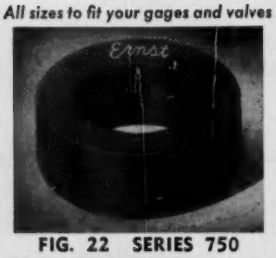


FIG. 22 SERIES 750

FIG. 21 LIP-MOLD

STATE YOUR REQUIREMENTS

All shipments from stock.
Send for Catalog

ERNST WATER COLUMN & GAGE CO.
Livingston 6-1400 LIVINGSTON, N. J.

"ECLIPSE" Ammonia and F-22 Compressors
Large "ECLIPSE" 9-Cyl. Compressor
"ECLIPSE" Compressors, 2, 3, 4, 6 or 9 Cylinders
Small Ammonia & Freon-22 Compressors
83 TYPES AND SIZES OF
FRICK
REFRIGERATING MACHINES
Most comprehensive line of compressors in the Industry. There's one to meet the needs of your business exactly. Handle any commercial or industrial load, at any temperature, with any refrigerant! Get the full facts and figures now: write, wire or phone
FRICK CO.
WAYNESBORO, PENNA. U.S.A.
"ECLIPSE" Low Pressure Units in 5 Sizes
Accessible-Hermetic Units, ½ thru 7½ Hp.
Open-drive Low Pressure Units, ¾ to 15 Hp.
Booster Compressors for Low Temperatures
Combined Ammonia Units in 3 Sizes
Large 2-Cyl. Ammonia Compressors
Large 4-Cylinder Compressors—Up to 700 Hp.

REPORTS from the FIELD

Begins on page 156

science and art of engineering as related to air moving and conditioning devices as well as perfect methods for testing such devices for performance. The Association also proposes to collect and disseminate lawful information of value to the membership, industry and public regarding products and their application.

Representing a wide range of products the Association functions through Products Divisions—composed only of those members actively engaged in the manufacture of products included within the scope of a Division. Original Divisions established are: (1) Central Station Air Conditioning Unit Division (2) Centrifugal Fan Division (3) Industrial Axial and Propeller Fan Division (4) Power Roof Ventilator Division (5) Residential Fan Division (6) Unit Heater Division.

Officers elected were: R W Nelson, American Air Filter Co, Inc, president; J F Snow, Davidson Fan Co, vice-president; C C Cheyney, Buffalo Forge Co, vice-president; W H Rietz, Ilg Electric Ventilating Co, secretary-treasurer.

Association headquarters are at 2159 Guardian Bldg, Detroit 26, Mich.

Nuclear technology conference to be held on May 15, 16

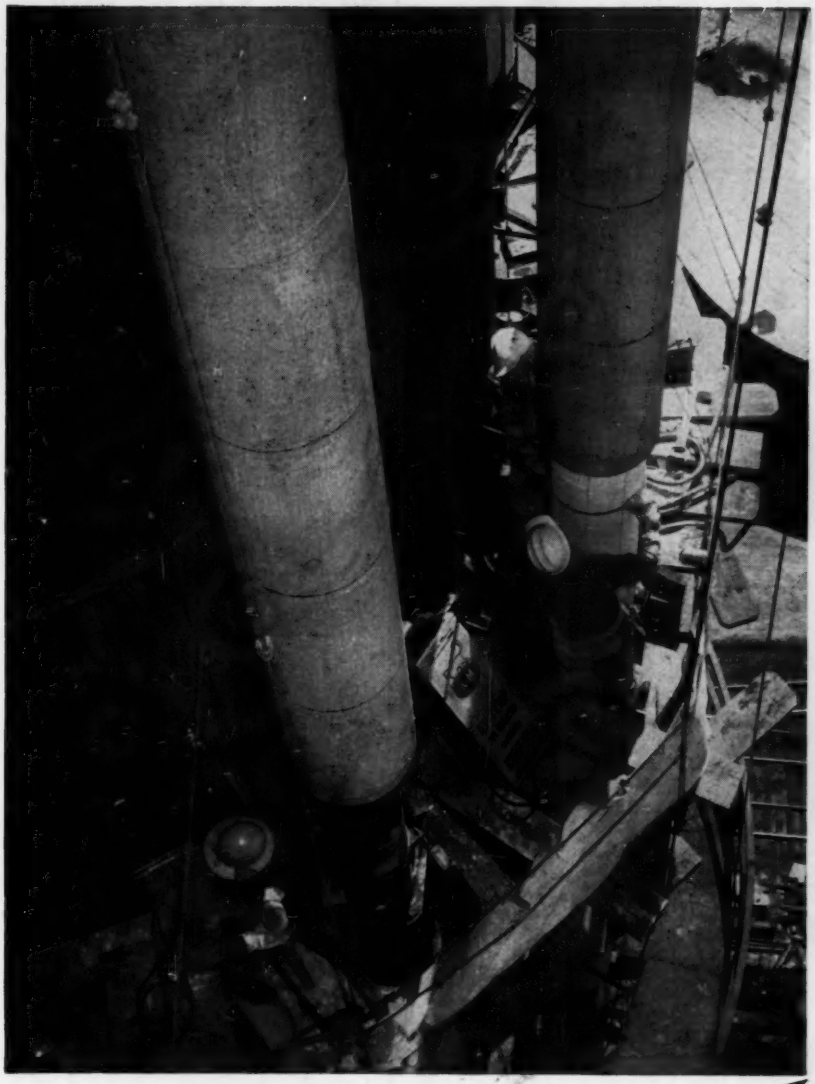
► NUCLEONICS, a McGraw-Hill publication, will cosponsor an Industrial Nuclear Technology Conference with the Armour Research Foundation of Illinois Institute of Technology on May 15, 16. The meetings will be held at the Museum of Science and Industry, Chicago, and will cover uses of radioactive materials in many industries, in chemistry and biology. Radiation sources and nuclear instrumentation will also be covered.

General information can be obtained by contacting Joseph J Kowal, Conference Secretary, Armour Research Foundation of Illinois Institute of Technology, 10 W 35th St, Chicago 16, Ill.

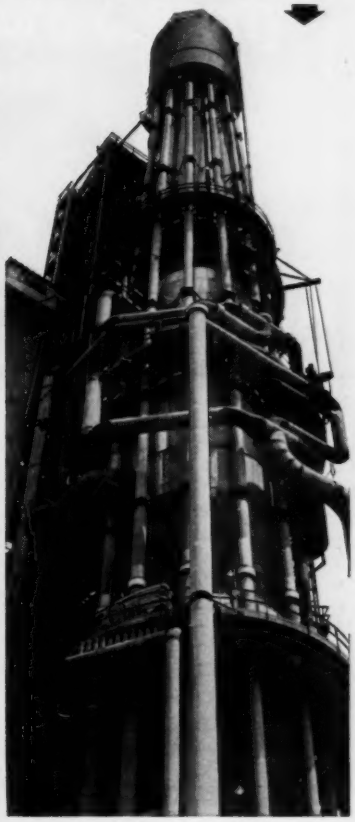
Soviet Union announces new five-year plan

► MOSCOW, *McGraw-Hill World News.* Russia has announced an all-out drive to "overtake and surpass" the Capitalist West in industrial, atomic and agricultural development.

The challenge came in a new five-year plan issued by the Soviet Communist Party covering the years 1956-1960 inclusive. Targets call for a steady expansion of heavy industrial output until by the end of 1960 a norm is reached of 53 million tons of pig iron,



The World's Largest Houdriflow, at the Sun Oil Company refinery, Marcus Hook, Pa., is 350 feet high. Lift piping to its reactor tank is insulated with a combination of K&M Hy-Temp andK&M "Featherweight" 85% Magnesia.



Easily Applied, Hy-Temp and "Featherweight" insulations quickly go on 14′′ lift pipes high above ground. This huge catalytic petroleum cracking unit embodies some 2½ miles of insulated piping. Insulation contractor: Armstrong Cork Company.

K&M Thermal Insulations help keep the world's biggest "cat" purring

It takes plenty of heat to crack petroleum. This king-size catalytic cracking plant ("cat") works 24 hours a day, seven days a week—with operating temperatures as high as 1500°F. K&M Thermal Insulations minimize heat loss and keep heat on the job here, just as they do in power plants, factories, and institutions the country over.

K&M "Featherweight"® 85% Magnesia and Hy-Temp Insulations withstand moisture, vibration, frequent temperature changes. For efficiency to 1900°F., these insulations are applied in combination, with staggered joints. This eliminates heat loss that normally occurs in single-layer installations when expansion causes joints to open. "Featherweight" is efficient to 600°F. when used solely.

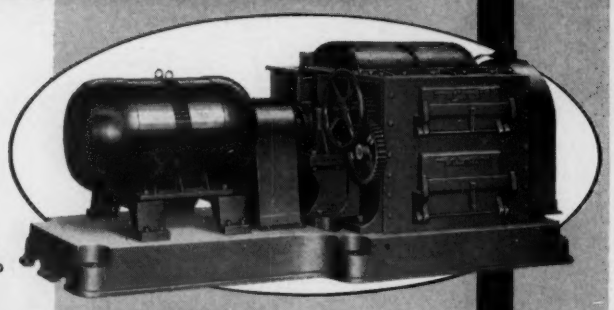
Plan your new plant with these heat-saving, cost-saving insulations in mind. Bring your present plant up to date with K&M Thermal Insulations. Contact your K&M distributor, an experienced applicator, for full details. Or write directly to us.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

K&M best in asbestos®

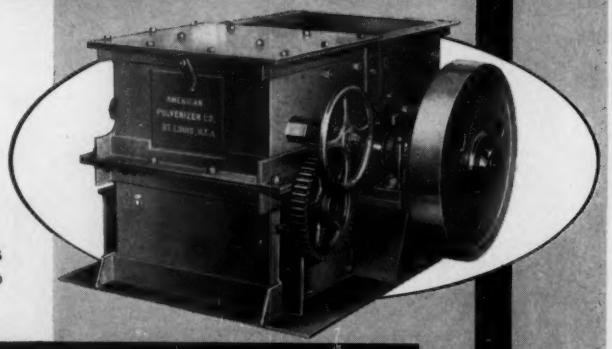
In Canada: Atlas Asbestos Company, Limited, Montreal, Toronto, Winnipeg and Vancouver.

When You Figure . . .



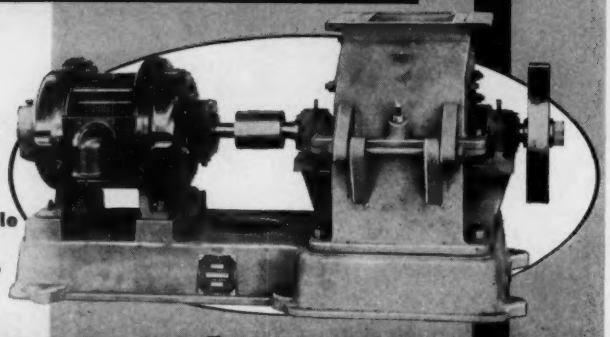
AC Series
capacities to
800 TPH

Reduction Cost Per Ton . . .



WC Series
capacities to
90 TPH

the Best Answers*. . .



Coal Sample Crushers
capacities to
2000 Lbs.
Per Hr.

Come from *American* Ring Coal Crushers

*In a recent independent survey, it was found that American Crushers reduced over 61,000,000 tons of coal at a parts replacement cost (including standby parts) of *less than 1/10th of 1¢ per ton.*

THERE CAN BE NO BETTER PROOF OF AMERICAN QUALITY!

American PULVERIZER COMPANY

WRITE for Literature on These Crushers

Originators and Manufacturers of Ring Crushers and Pulverizers

1349 MACKLIND AVE. • ST. LOUIS 10, MO.

REPORTS from the FIELD

Begins on page 156

68.3 million tons of steel, 593 million tons of coal and 320,000 million kwhr of electrical energy. The goal for electricity represents almost a 100% increase over 1955.

The latest plan is the sixth to be launched by the Soviet Union since Stalin ordered the first in 1928—eleven years after the Russian revolution.

Calendar of Events

Apr 10-12—Metal Powder Association, 12th Annual Meeting and 1956 Metal Powder Show, Hotel Cleveland, Ohio. For details write MPA, 420 Lexington Ave, New York 17, N. Y.

Apr 16-18—American Society of Mechanical Engineers, first Gas Turbine Power Conference, Hotel Statler, Washington, D.C. Full information from ASME, 29 W 39th St, New York 18, N. Y.

Apr 16-18—American Institute of Electrical Engineers, Great Lakes District Meeting, Fort Wayne, Ind. Details from AIEE, 33 W 39th St, New York 18, N. Y.

May 2-4—American Institute of Electrical Engineers, North Eastern District Meeting, Rochester, N. Y. Details from AIEE, 33 W 39th St, New York 18, N. Y.

May 7-9—Air-Conditioning and Refrigeration Institute, Annual Meeting, The Homestead, Hot Springs, Va. For details write ARI, 1346 Connecticut Ave, NW, Washington 6, D.C.

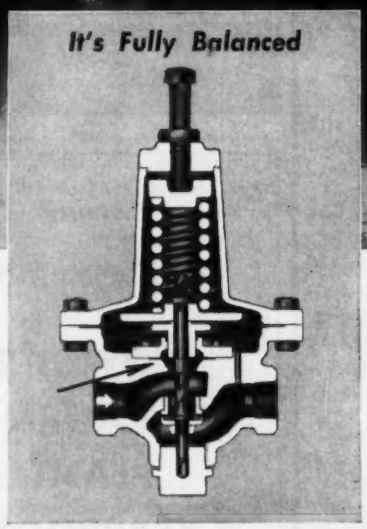
May 9-10—National Association of Corrosion Engineers (Niagara Frontier Section) and University of Buffalo, symposium on control of corrosion in the chemical industry and proper use of metals and alloys for corrosion prevention. University of Buffalo campus. Further information from Industrial Liaison Office, University of Buffalo, Buffalo, N. Y.

May 9-11—American Welding Society, National Spring Meeting and fourth Welding Show. Memorial Auditorium and Hotel Statler, Buffalo, N. Y. Details from AWS, 33 W 39th St, New York 18, N. Y.

May 14-17—American Society of Mechanical Engineers, Design Engineering Conference to be held at same time and place as the first Design Engineering Show (an industrial exposition produced by Clapp & Poliak, Inc, New York). Convention Hall, Philadelphia, Pa. Details from ASME, 29 W 39th St., New York 18, N. Y.

May 15-16—Industrial Nuclear Technology Conference, sponsored jointly by Nucleonics magazine and Armour Research Foundation of Illinois Institute of

Here is the new LESLIE "HI-FLO" Water Reducing Valve with 50% more capacity



Unique construction of "Hi-Flo" Reducing Valve. Note the small lower diaphragm that provides fully balanced, floating action.

HERE IS THE ALL NEW Leslie Reducing Valve with *capacity-regulation* features that have never been offered before. Here is a regulator with 50 - 100% greater capacity by actual test.*

Here's the unbeatable combination of design features:

"HI-FLO" — Large bowl construction; long stroke diaphragm gives full flow of water and other non-corrosive liquids.

FULLY BALANCED — The main valve, fully balanced by lower diaphragm, virtually floats to provide smooth, friction-free, throttling action.

DROP-TIGHT SHUTOFF — Resilient seating disc provides tight closure under all conditions.

TROUBLE-FREE DESIGN — Chatter and hammer eliminated; no piston cups or seals to clog or change. Corrosion resistant trim with renewable interchangeable fit.

Ask your Leslie Engineer to show you how the exclusive Leslie "Hi-Flo" valve can be used to your advantage in water reducing stations, fuel oil pressure control, process lines, etc. He's in your classified directory under "Valves" or "Regulators".

Write today for Bulletin 553 for graphic performance comparison and complete capacity data.

TRADE LESLIE MARK

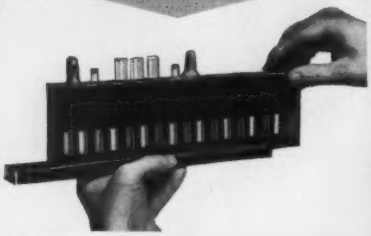
REGULATORS AND CONTROLLERS

LESLIE CO., 235 GRANT AVENUE, LYNDHURST, NEW JERSEY

139

CONTROLLED QUALITY MEANS QUALITY CONTROLS

ACCURATE
pH, PHOSPHATE
CONTROL
with
TAYLOR COMPARATORS
REDUCES WASTE



Help determine EXACT amounts of chemicals needed for adjustments

By making accurate colorimetric tests of pH and phosphate content with Taylor Comparators, you can be sure of determining the exact amounts of chemicals needed to control scaling, corrosion and priming in boilers. Tests can be made in minutes—no experience is needed. Just fill test tubes with sample, add reagent to center tube and move color slide across until colors match. Even complete water analysis is only a little more detailed with the Taylor Water Analyzer.

Water hardness may be determined with the ease and accuracy of an alkalinity titration with the Taylor Total Hardness Set.

COLOR STANDARDS GUARANTEED

Taylor liquid color standards carry an unlimited guarantee against fading. There's no chance of mechanical inaccuracy. Each complete set of standards is mounted in a lightweight, plastic slide, eliminating the need for handling fragile, single standards.

SEE YOUR DEALER for Taylor sets, or write direct for FREE HANDBOOK "Modern pH & Chlorine Control." Gives theory and application of pH control, and illustrates and describes complete Taylor line.

W. A. TAYLOR AND CO.
YORK RD. & STEVENSON LANE • BALTO.-4, MD.

REPORTS from the FIELD

Begins on page 156

Technology, Museum of Science and Industry, Chicago, Ill. Details from INT Conference, Armour Research Foundation, 10 W 35th St, Chicago 16, Ill.

May 16-18—Society for Experimental Stress Analysis, William Penn Hotel, Pittsburgh, Pa. For details write Dr W M Murray, SESA, P.O. Box 168, Cambridge 38, Mass.

May 17-19—New York State Society of Professionnal Engineers, 30th Engineering Industries Exposition and Annual Convention. Hotel Statler, New York City. Details from Mr George Baer, chairman, c/o Foster-Wheeler Corp, 165 Broadway, New York, N. Y.

May 21-24—Air Pollution Control Association, Niagara Frontier Annual Meeting, Buffalo, N. Y. Details from APCA, 4400 5th Ave, Pittsburgh 13, Pa.

New firm to specialize in thermal process technology

► Dr Donald Q Kern has announced the formation of D Q Kern Associates with offices at 7016 Euclid Ave, Cleveland 3, Ohio and branches in New York and Washington, D.C. The firm specializes in thermal process technology with particular reference to design, engineering and marketing of thermal process components.

Connected with the organization are five associates of prominence in the fields of distillation, high-pressure techniques, nuclear engineering, heat transfer and thermodynamics. The supporting staff is comprised of 50 chemical, mechanical and structural engineers, detailers, analysts and draftsmen.

Tide Water Refinery to purify cooling water

► A total of 275,000 gallons of water will be pumped every minute by the water pumping station now being constructed to serve Tide Water Associated Oil Co's Delaware Flying-A Refinery, 15 miles south of Wilmington.

Located on the mouth of Cedar Creek near Delaware City, the pumping station will house nine 2000-hp electric pumps. These pumps will draw water from the creek where it flows into the Delaware River and drive it into two 78-in. mains that run up a 55-ft grade and circulate it through 15 miles of pipes to cool the refinery units.

To move the tremendous flow of water 24-hrs a day, the pumps will require one-third of the refinery's total electric power consumption.

Water will pass through three subterranean artificial waterfalls to check

The Greater the Pressure... the Tighter It Holds!

There's still nothing simpler or more efficient in power line service than this Wilcox Self-Sealing Gasket which has served industry so well over the years. The U-shaped metal outer cover is packed with a resilient filling (usually rubber or asbestos). Pressure exerted on this elastic filling forces it into the cover, putting force against the adjacent flange surfaces. Thus, internal pressure that tends to blow ordinary gaskets makes the Wilcox Gasket tighter in the joint. Available with covers of copper, lead, tin, aluminum, monel, stainless steel, etc. in all sizes—standard or special.

Write for details and quotations

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PERSONAL DEMONSTRATION

shows how you can

INCREASE PLANT PRODUCTION

Our representatives throughout the nation are ready to demonstrate *a complete* Omniguard system right at your plant or office.

Takes Only a Few Minutes to Prove Simple Omniguard System Protects Bearings and Processes; Cuts Down Time; Increases Equipment Life

Just take a few minutes to prove to yourself how Omniguard can make it possible for you to operate your equipment at peak production rates without fear of breakdowns . . . how this simple temperature detection system gives you ample opportunity to prevent bearing failures or to keep process temperatures within limits.

RECORDS REVEAL FAILURES COSTLY

Many operators—after a record check—are astonished to find how much bearing breakdowns have been costing them in maintenance and lost production. They see that the cost is often many times the expense of installing Omniguard.

COMPLETE 4-POINT SYSTEM FOR LESS THAN $500

Consider the thousands of dollars involved in equipment and production output. Contrast this with the fact that one Omniguard unit costs less than $500. And because of its simplicity, installation costs are also low.

SIMPLE, DEPENDABLE

Omniguard has no electronic or moving parts. It is the most dependable system available today. Modular in design, each unit gives you four-point detection. You can add as many as you need . . . as you need them.

The modular indicator and monitor, with their mounting brackets, and the resistance temperature detectors, are all you need for a continuous operating analysis of remote process or bearing temperatures.

Resistance Temperature Detectors

These are just four of the many different types of temperature detectors produced for varied applications of the Omniguard system.

The 242P for high temperatures (to 1300°F.)

The 166NC with pre-loaded sensitive tip specially designed for bearing protection.

The 230N for general purpose industrial use (stem-sensitive).

The 235N90-35 for fast response in corrosive service.

A Partial List of Present Users

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City of Chicago
Combustion Engineering, Inc.
DeLaval Steam Turbine Co.
Eastman Kodak Co.
Esso Standard Oil Co.
Florida Power & Light Co.
General Electric Co.
Hercules Chemical Co., Inc.
I-T-E Circuit Breaker Co.
North American Aviation, Inc.
Public Service Electric & Gas Co.
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BOILER FEED PUMPS

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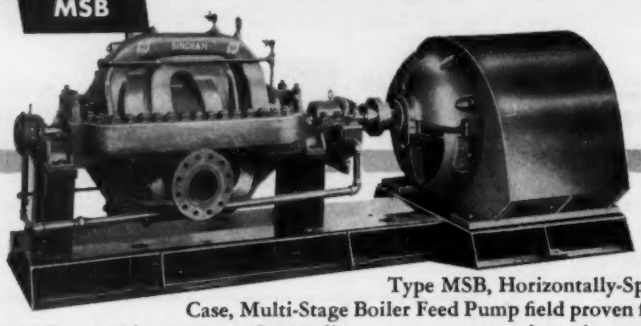
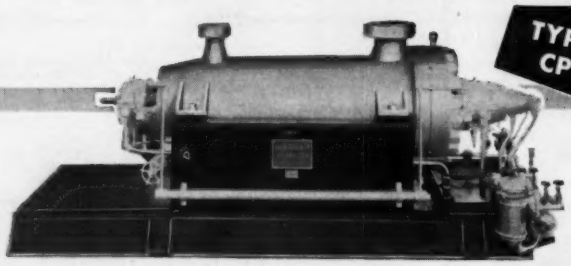
TYPE MSB



Type MSB, Horizontally-Split Case, Multi-Stage Boiler Feed Pump field proven for 1200 lbs. working pressure. Integrally cast cross-overs and evenly spaced case bolting located uniformly close to the shaft center line, enclosing a minimum pressure area, eliminate case distortion and inter-stage jetting.

TYPE CP



Type CP, Multi-Stage, Double-Case Boiler Feed Pump with forged outer barrel for high pressure service.

All BINGHAM Boiler Feed Pumps feature: (1) "Double Volute" construction, resulting in full radial balance of the rotating element *throughout the entire operating range of the pump.* (2) Double suction first stage for low NPSH. (3) Balanced axial thrust (no balancing drums needed). (4) Kingsbury Thrust Bearings. (5) Stuffingboxes subjected to suction pressure only. (6) Design for High Speeds.

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New Orleans, La.	Toronto, Ont., Can.
Vancouver, B. C., Canada	

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the force of its downhill return trip and will be circulated through separators before it re-enters the Delaware River.

A channel 40-ft deep is being dredged in the creek to facilitate flow of the river water into the pumping stations. Work also has begun on a large intake basin containing debris screens and chlorinators. The chlorine treatment will purify incoming water on its way to the pumps—protecting the equipment. For repairs and maintenance, the pumps can be shut off three at a time, and the system will still operate adequately. The pumps will also be served by dual underground power lines—one being on standby for emergencies.

Electrostatic precipitation is theme of seminar

► A SEMINAR PRIMARILY for engineers responsible for operations of electrostatic precipitation equipment will be held at The Pennsylvania State University, June 11-15.

During the first day and one-half, Dr H J White of Research Cottrell, Inc, will discuss principles underlying the electrostatic precipitation process. Remainder of the seminar will be concerned with several areas of electrostatic precipitator applications: public utilities, the steel industry, air cleaning for air conditioning and other uses.

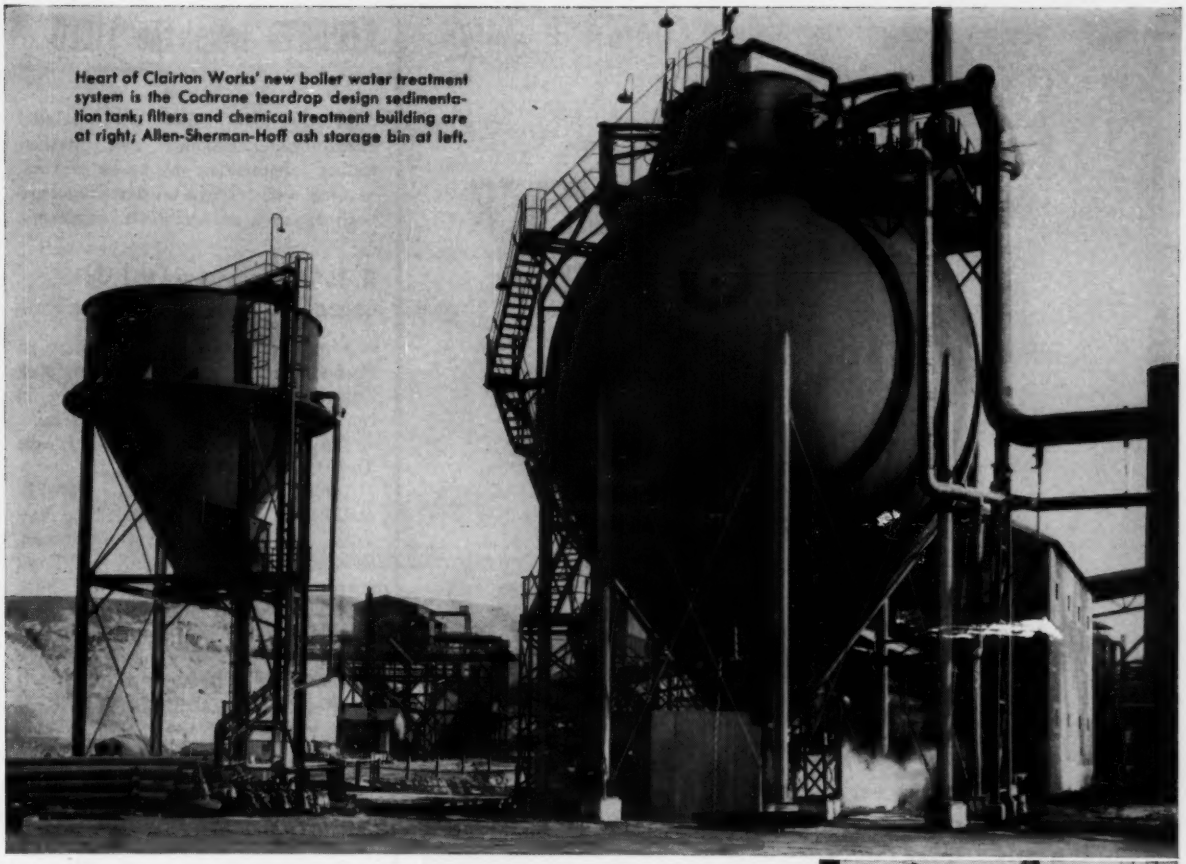
Further details may be obtained by writing General Extension Information, The Pennsylvania State University, University Park, Pa.

Combustion Engineering, Inc to build nuclear center

► COMBUSTION ENGINEERING, INC has contracted for the purchase of a 530-acre site in Windsor, Conn., on which it will build a Nuclear Engineering and Development Center, it was announced by Broderick Haskell, vice-chairman of the company.

The Center will comprise facilities for the complete design and development of nuclear power reactors, for construction of reactor cores and for manufacture of related atomic fuel elements. Costing upwards of $5-million the Center will begin operations late this year and by 1957 will employ several hundred people—largely engineers, scientists and technicians.

A large engineering and administrative building, a critical-experiment facility for studying the physics and nuclear characteristics of reactor cores, a "hot" laboratory and a fuel element



Heart of Clairton Works' new boiler water treatment system is the Cochrane teardrop design sedimentation tank; filters and chemical treatment building are at right; Allen-Sherman-Hoff ash storage bin at left.

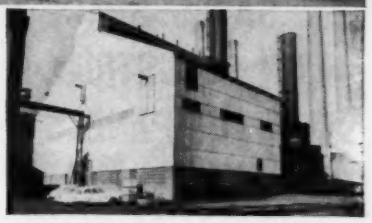
How U. S. Steel solved a construction-production problem at Clairton

For several years engineers at U. S. Steel Corporation's Clairton Works searched for ways to meet increased steam demands at their coke oven and benzol plants. Existing boilers were being pushed to capacity and production requirements were mounting so rapidly that the only logical solution was new boiler facilities . . . but such a project presented several formidable problems as production would have to be maintained during construction, and the expansion had to be confined to a limited area to allow future expansion.

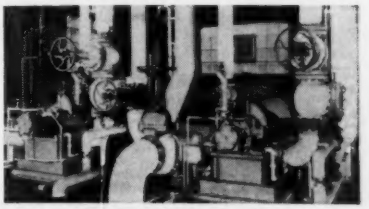
Solution to this problem is a good example of how Dravo's "complete package" construction service can work for you. After identifying their requirements and setting-up the necessary engineering specifications U. S. Steel engineers contacted Dravo for some preliminary estimates and construction ideas. What they received was a complete, coordinated plan for the whole program that relieved them of the multitude of planning details and permitted their dealing with one prime source of responsibility for the entire project.

Result was construction by Dravo of an expandable boiler plant and water treatment system to their requirements and without a day's loss of production time. The new plant is capable of supplying 200,000 lbs. of 600 degree steam per hour at 250 pounds pressure and treating 100,000 gallons of water per hour with a deaerating capacity of 80,000 lbs. per hour.

You, too, can profit through Dravo's single-contract responsibility, ranging over all types of jobs from boiler plant construction to the installation of a pump. Write for complete information.



Exterior of the new boiler house. Initial operation at 165 lbs. pressure to tie in with equipment in original boiler house, at right.



De Laval boiler feed pumps and Dravo fabricated piping are part of the equipment installed by Dravo.

Dravo Corporation, Department C-2104
Fifth & Liberty Avenues
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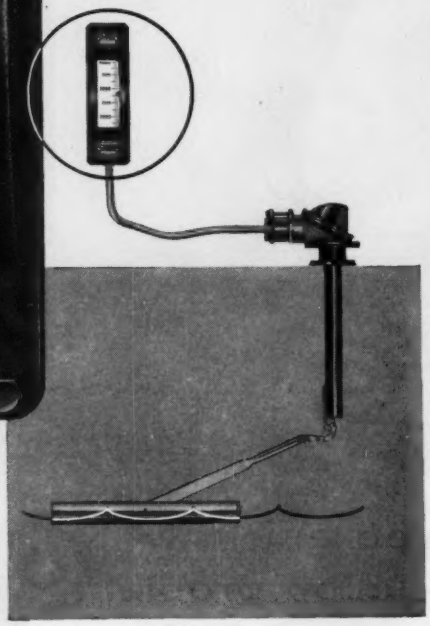
NEW LIQUIDOMETER INDICATOR



SAVES SPACE ON INDUSTRIAL CONTROL PANELS

Twenty-inch dial in 3 x 10¼" case permits close readings

The new Liquidometer Model 216 Indicator gives the plant engineer a reliable, automatic reading of storage tank contents. Available in either vertical or horizontal design, the compact and highly readable Model 216 Indicator makes possible multiple installations on crowded control panels.

Teamed with Liquidometer's time-tested hydraulic transmission gaging system, the new indicator provides instantaneous remote indication of liquid levels—automatically. No outside power source is required. Virtually any liquid may be measured, and the indicator can be located up to 250 feet from the tank.

Engineered for dependability, the Liquidometer gaging systems highlight these design features:

- Maintenance free
- Integral temperature compensation
- Ease of installation—requires only one 2" diameter tank opening
- Safety—all gages Underwriters approved for hazardous liquids

For further details on the new Model 216 Indicator, write Dept. E for Bulletin 532.

THE LIQUIDOMETER CORP.
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fabrication plant, together with related metallurgical, chemical and physical testing laboratories, are to be erected. Stone & Webster Engineering Corp have been engaged as architects, engineers.

N. Y. State engineers to hold annual convention, exposition

► THE NEW YORK STATE Society of Professional Engineers will run its 30th Engineering Industries Exposition in conjunction with its annual convention on May 17-19, at the Statler Hotel, New York City.

Among the companies who have already contracted to exhibit are the New York Telephone Co, D B Steinman, Reliance Steel, Industrial X-Ray Engineering, Portland Cement, New York Traprock, Borden Metal Products, Raymond Concrete Pile, Consolidated Edison, Owens-Corning, General Electric, Foster-Wheeler, Bethlehem Steel, H H Robertson, General Precision Laboratories and others.

Consolidated Edison Co will exhibit a scale model of the reactor it is building at Peekskill to supply atomic energy to New York City.

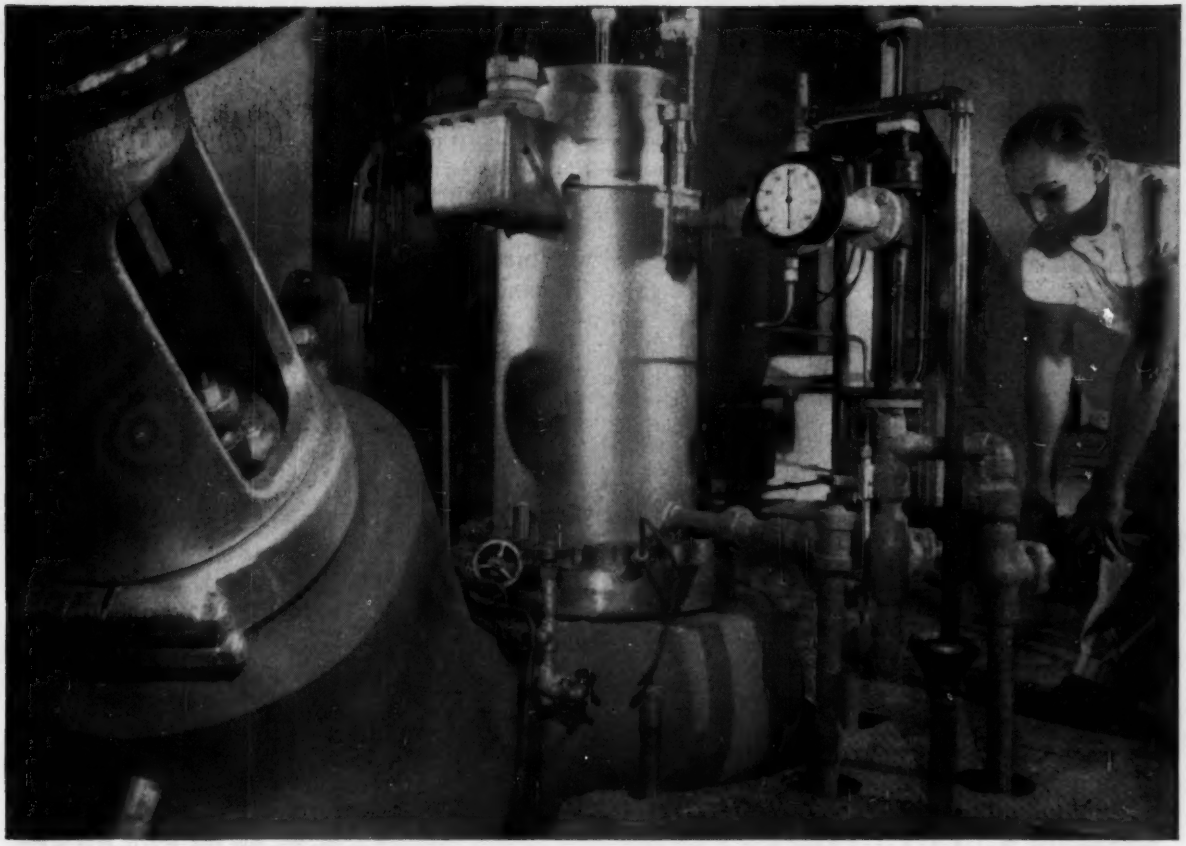
The Society's awards for distinguished service to the engineering profession will be given to General Omar N Bradley and to Vincent G Terenzio P E of the New York City Board of Water Supply.

Revive plans for Argentine-Uruguayan hydro plant

► BUENOS AIRES, *McGraw-Hill World News*. Plans for a billion dollar joint Argentine-Uruguayan hydroelectric plant are being revived. The project calls for construction of twin power stations at Salto Grande—one on either side of the Uruguay River which forms the boundary between the two countries. Each will have a potential of 700,000 kw.

Preliminary studies have been made at intervals beginning in 1907. However, the rise of dictator Peron in Argentina resulted in such strained relations between the two countries that progress was halted. Following the fall of Peron, discussions of the project have been revived. While no official announcements have been made, representatives of engineering firms on both sides of the boundary are following progress of negotiations closely.

Although Uruguay is looking ahead and does not envisage total consumption of her plant's output until 1970, power-hungry Argentina could today consume every kw of the 700,000 her plant will



This "canned" motor-pump...comprising a pressure-tight cell that houses stator and rotor (each in sealed "cans") plus impeller...circulates 4700 gpm of 605°F water at 1725 psi continuously in a closed loop system. Units can be built for pumping 5 to 17,000 gpm at pressures up to 2500 psi at 650°F; units for liquid metal, to 1000°F. A development of Atomic Power Div., Westinghouse Electric Corp.

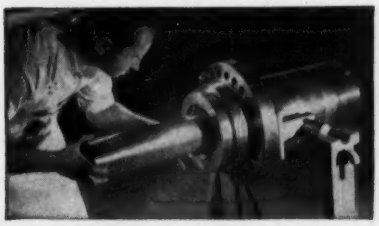
Pump made leak-proof...needed Inconel

For steam plants *today*...atomic plants *tomorrow*

THIS IS a "canned" motor-pump. It's completely sealed to circulate coolant in a closed system for as long as 20 years!

Without maintenance or leakage

Zero leakage is an essential for nuclear reactors, because their coolants absorb neutrons and become radioactive. Even the *smallest* leak could spell disaster.



Inconel liner seals stator from coolant. Another seals rotor. Liquid being pumped can flow between. No external shaft seals. No packing problem. Developed by Westinghouse to meet a need on atomic powered U.S.S. *Nautilus*.

The canned pump may also prove a great advance for other high-temperature, high-pressure uses.

Basic to its success is Inconel* nickel-chromium alloy. Inconel helped the designers lick the induction-motor-operating problem caused by two metallic walls between stator and rotor.

Making the walls of Inconel — *thin* Inconel — gives them high electrical resistivity. Minimizes current loss. And there's no interference with magnetic fields.

In addition to being non-magnetic, Inconel nickel-chromium alloy provides high strength at 1000°F and above. It resists corrosive attack and stress-corrosion cracking, too.

The canned motor-pump is but one of many examples of why you'll find Inco Nickel Alloys in tomorrow's nuclear-energy equipment . . . and in today's power plants.

Right now, consider *your own* particular problem. Perhaps an Inco Nickel Alloy will provide the exact physical, chemical and electrical properties you need. Let us help you find out. Write Inco's Technical Service Section for suggestions. There's no obligation.

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The Cincinnati Tool Co.

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SPEARHEAD EXTENSION GASKET CUTTER

"In the past 50 years we've tested virtually every gasket cutter on the market, but without question, this new extension model is the most practical yet! It has the simplest, most practical design of any gasket cutter I've ever seen . . . the aluminum body is lightweight and has smooth rounded edges that makes it convenient to handle. Its wide range of uses amazes me. I was sold the first time I tried one!"

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You'll be sold too, after you try one and prove to yourself how efficient this new Spearhead Extension Gasket Cutter really is. This hand tool will cut solid diaphragms and disks, shims, patterns and round gaskets *any size*. Pliable sheet materials like .005" vegetable fibre, ⅛" compressed asbestos, and 1" rubber can be readily cut.

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produce—and more. Either the Export-Import Bank or the International Bank for Reconstruction and Development will be asked to finance the project.

Reactor experiments progress at University of California

► *McGraw-Hill Pacific Coast News Bureau.* Research, design and construction are currently underway at the University of California's Los Alamos, N. M. scientific laboratory which may lead to design of a nuclear reactor capable of supplying Los Alamos with power. A small package power reactor that can be easily transported to remote areas may result from the experiments.

Experiment No. 1 at Los Alamos concerns a power reactor now in the final assembly stage. Although it is expected to produce high-temperature superheated steam suitable for modern turbines, no turbine-generator installation will be made in this experiment. Reactor is a homogeneous type with forced fuel circulation, utilizing an enriched uranium, phosphoric acid and water solution. It is cooled by forming steam in a heat exchanger.

Experiment No. 2 involves a simplified power reactor with no moving parts. It is designed for safe operation without an attendant and suited for package power applications. This is a homogeneous, convection-cooled reactor and also uses an enriched uranium, phosphoric acid and water solution for fuel.

Three other reactor projects are also underway at the laboratories.

Elecric shock can cure ventricular fibrillation

► NEW EXPERIMENTS indicate that electric shock can restore the heart to normal action from a condition of ventricular fibrillation.

Dean W B Kouwenhoven, Johns Hopkins School of Electrical Engineering, described the experiments at the AIEE Winter General Meeting. Using dogs, he is attempting to develop "simple, effective capacitor discharge equipment for bringing the ventricles of the fibrillating (dangerously fluttering) heart to rest without opening the chest."

Investigation shows that capacitors charged to low energy when discharged through a normal heart can throw it into ventricular fibrillation. But the proper amount of electricity can also restore normal action.

"In the case of the exposed heart, a capacitor discharge at 500 volts or more and of an energy equivalent to five watt-

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Ideal wherever an accurate check is needed on recording or controlling instruments. Available in many standard ranges and mounting angles. BINOC* tubing makes it 3-times-easier-to-read.

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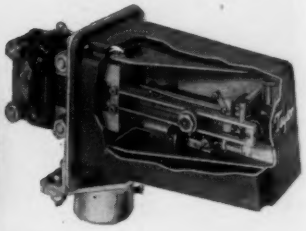
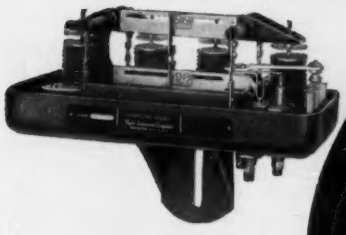
A rugged, dependable and accurate instrument designed to measure flow, liquid level or specific gravity. Taylor's latest addition to TRANSET System of transmitters, receivers and controllers.





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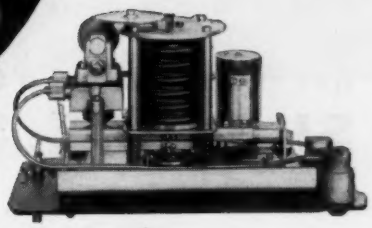
TRANSET* COMPUTING RELAY

A pneumatic, force-balance transmitter for adding, subtracting, averaging and ratioing. For intricate applications requiring close computing accuracy. Handles up to 3 separate pneumatic input pressures with .5% accuracy.



TRANSAIRE TEMPERATURE TRANSMITTER

Compact and super-responsive. Designed to measure and transmit smallest temperature changes up to 1,000 feet with great accuracy. Provides dynamic accuracy, thanks to derivative action in the measuring circuit. Similar instruments for highly accurate pressure measurement.

FULSCOPE* RECORDING CONTROLLER

For desuperheaters, or for any close, accurate control of temperature, pressure, flow or liquid level. Quickly adapted to operating requirements.

IF YOUR COSTS seem to be running wild, and you're looking for ways to improve operating efficiency, then take a look at these Taylor instruments. They will give you real help in controlling costs and improving efficiency, because they're sensitive, accurate instruments, refined by years of engineering experience to do the job that you want done. And beyond that, they're a profitable investment because Taylor Instruments are built with an eye to simple design and rugged dependability—they'll last for years with a minimum of service.

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Ask your Taylor Field Engineer. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

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Builders Chlorinizers Offer:

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- **ECONOMY** . . . simple, compact designs provide low initial cost . . . minimum maintenance
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METERS FEEDERS CONTROLS

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seconds will successfully stop ventricular fibrillation provided it has not continued for more than a few seconds. With an intact chest and the same time limitations, energy in the discharge should be about 500 watt-seconds," Prof Kouwenhoven pointed out.

Improved incandescent lamps up output 6 to 15%

► DEVELOPMENTS now being placed in effect will cause increases in light output ranging from 6% for household bulbs to 15% for higher wattage bulbs used in industrial and commercial lighting. No more electricity is required. In making the announcement, General Electric Co described it as "the greatest single improvement in incandescent light bulb performance in 42 years."

Improved lamps are presently available in the 750 and 1000-watt sizes. Other sizes will be included within the next few years—as rapidly as equipment can be built and installed to mass produce them.

Increased light output is achieved by the following steps: (1) Improving the tungsten filament by making basic design changes. (2) Altering the mount structure so that the filament is positioned lengthwise, or axially, in the bulb. (3) Substituting for the first time coiled-coil filaments for singly coiled ones in lamps of 300 watts or larger.

Electronic brain records Niagara power generation

► AN ELECTRONIC BRAIN is keeping a sharp eye on generators converting Niagra Falls' energy to electricity, it was reported at the Winter General Meeting of the American Institute of Electrical Engineers.

"Operations Recorder" keeps a swift and accurate record of some 540 operations of the Sir Adam Beck-Niagara generating station No. 2 of Hydro-Electric Power Commission of Ontario. This permits control operators to make quick adjustments, J R Leslie, supervising and research engineer for the company, told a power generation symposium.

High speed printing annunciator lists the time, name and operation (closing or opening) of the 540 points at the rate of 10 points per second, Mr Leslie reported.

Detroit Edison is planning to add a 300,000-kw turbine-generator at the company's St Clair Power Plant, increasing the capability of the generating station to 940,000 kw.

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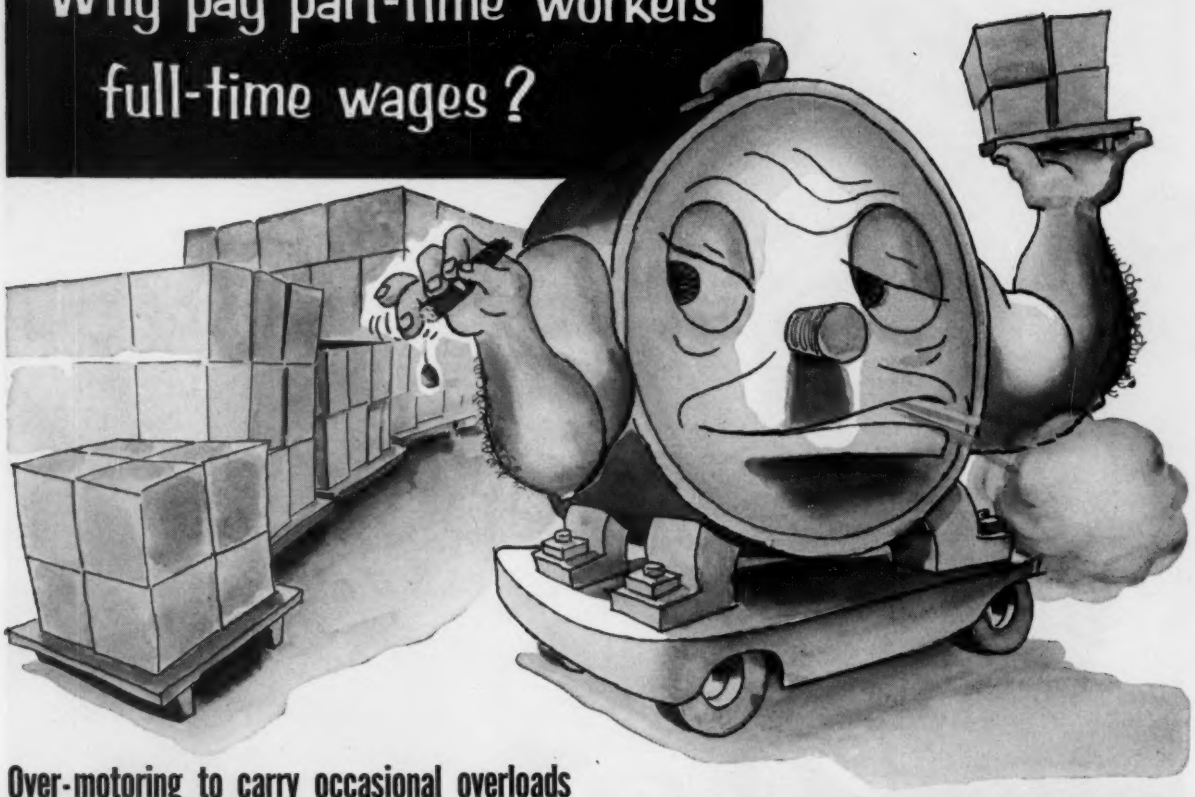

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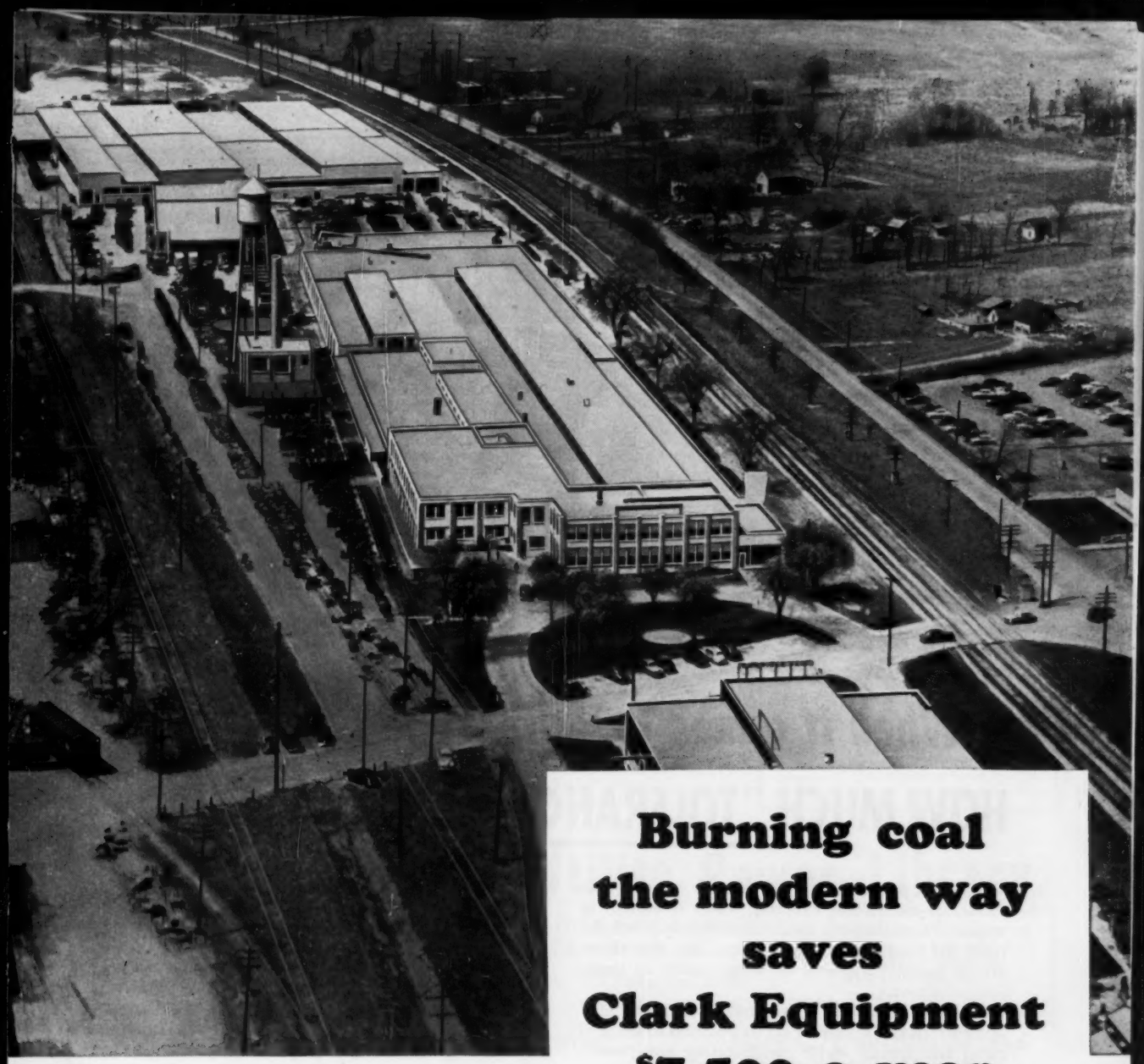

Burning coal the modern way saves Clark Equipment $7,500 a year

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facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems can cut your labor cost to a minimum. Coal is the safest fuel to store and use • No smoke or dust problems when coal is burned with modern equipment • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

Expanding production facilities at Clark Equipment Co., Battle Creek, Mich., created a need for more steam within the plant. In the face of rising overall costs, Clark engineers decided to meet this demand by modernizing the firm's power system.

Today, two watertube boilers utilizing spreader stokers have replaced three firetube boilers, underfeed fired. Stokers are fed by screw conveyor and controls are fully automatic. As a result of these and other aspects of its modernization program, Clark's boiler plant has now increased plant efficiency, supplying reliable, low-cost steam for all purposes—at a savings of $7,500 a year.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

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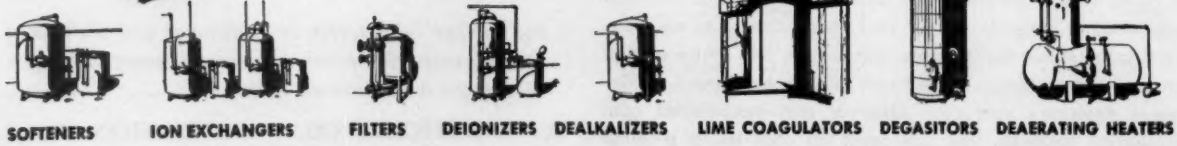

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"We hear much about the demand for engineers. One obvious remedy is to increase the number of well-trained engineering technicians. Many times we find engineers doing jobs that could be performed as well, at least in part, by technicians. The best figures now available call for at least five engineering technicians to each professional engineer on the engineering team. Our current situation is almost the reverse — four engineering graduates to each technician. This doesn't mean we need fewer engineers. Rather, it means the engineers will need more co-workers."

From an editorial in POWER

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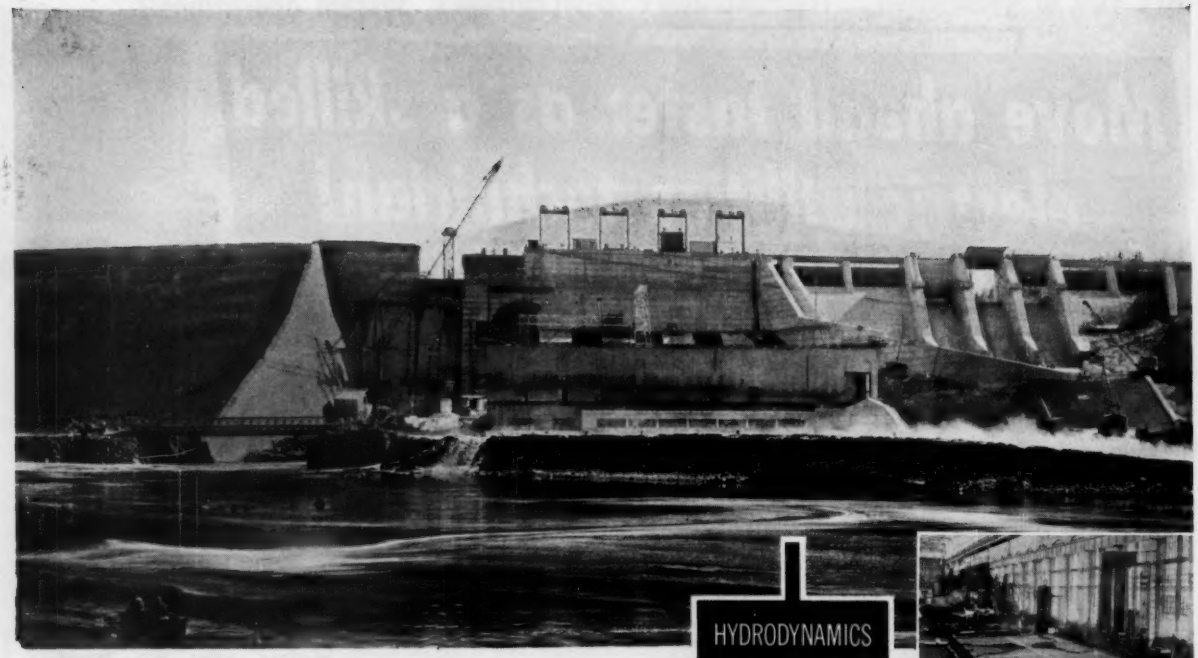
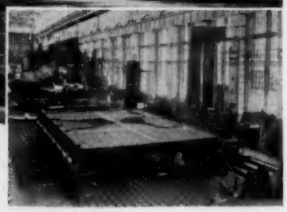


Looking upstream across the tailrace area, the SMS-Fixed Wheel Intake Gate on Unit #3 can be seen being lowered into position atop the dam.



Two halves of a gate have been assembled and aligned on a 7-inch bar horizontal boring mill. SMS bores wheel axle holes in this manner to assure accurate alignment within close tolerances.

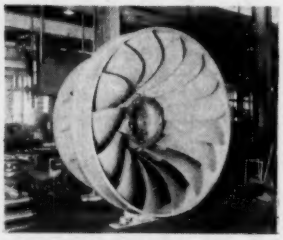
SMS-Francis Turbines At Littleton Development To

GENERATE PEAK POWER

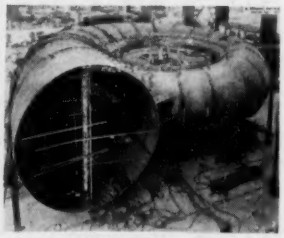
To meet rapidly increasing demands within the New England Electric System's area, Moore Station near Littleton, New Hampshire, will soon go on the line delivering peak load power. Rated at 150,000 kw, this new hydro plant is the third and last on the Fifteen Mile Falls stretch of the Connecticut River. Including the Comerford and McIndoes Stations immediately downstream, this will give a total capacity of 310,000 kw in a river fall of 367 feet at this location. Thus the largest of New England's rivers becomes one of the most highly developed streams of its size.

All three of the Fifteen Mile Falls plants are powered by SMS turbines. The four Littleton units are the vertical Francis type, each rated at 56,400 HP under a 150-foot head. SMS also provided four 18-foot x 24-foot fixed wheel intake gates for operation with an 84-foot head on the sill of the gate frame. The gates are designed for closing under full discharge and opening under balanced hydraulic conditions.

These three plants, with both SMS-Francis and Kaplan turbines as well as accessories, illustrate S. Morgan Smith's ability to handle the needs of any hydro project. Over three quarters of a century's experience in hydraulic design and manufacture stand behind SMS equipment. For full information, write S. Morgan Smith Company, York, Pennsylvania.



Unit #3's runner, completed and ready for shipment.



The 198-inch diameter riveted plate steel spiral case (with riveted cover plates) for Unit #1, taken during assembly at SMS Plant #2.

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Today's boiler plant is only as efficient as the instrumentation which operates it. In selecting the correct equipment to assure completely automatic operation, to provide cost reductions through labor saving, and greater efficiency, the companies shown on these pages have looked to Hays. The newest in power plant design coupled with Hays workmanship and follow-through have given them the results they sought.

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Hays systems are engineered to your specific requirements by a staff of specialists with years of experience on hundreds of boiler plants from the smallest to the largest. The particular instrument and control "package" necessary to handle your conditions is selected from the Hays product line; panel design, complete wiring, conduit, piping and control system diagrams are closely checked to see that they fit your requirements.

NATIONWIDE SERVICE

Service on Hays products is available throughout the country. Trained service engineers, from the factory or from Hays representatives in principal cities, can provide "start up" calibration and adjustment as well as subsequent periodic preventive maintenance service on your equipment.

For best results you will want to confer with Hays Sales Engineers in the earliest stages of your planning.

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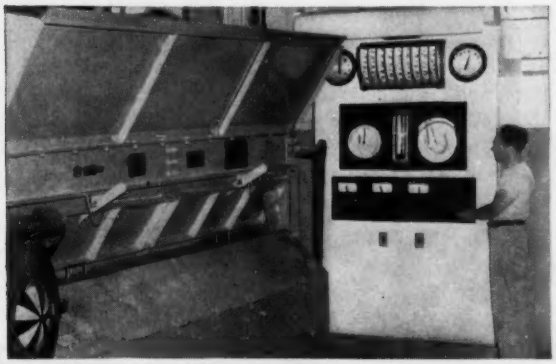
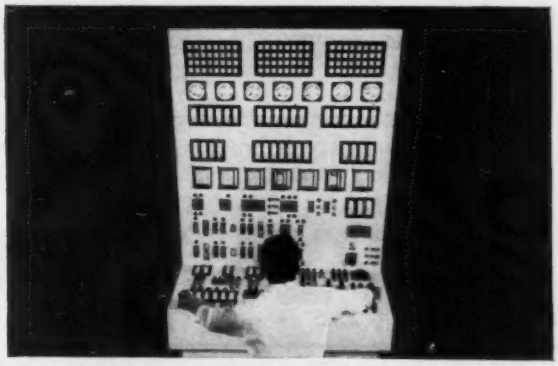
At Baldwin Locomotive Works, the Hays combustion control has aided substantially in saving 30,000 tons of coal per year and in reduction of maintenance. It is now possible to operate the power plant with 42 less men.

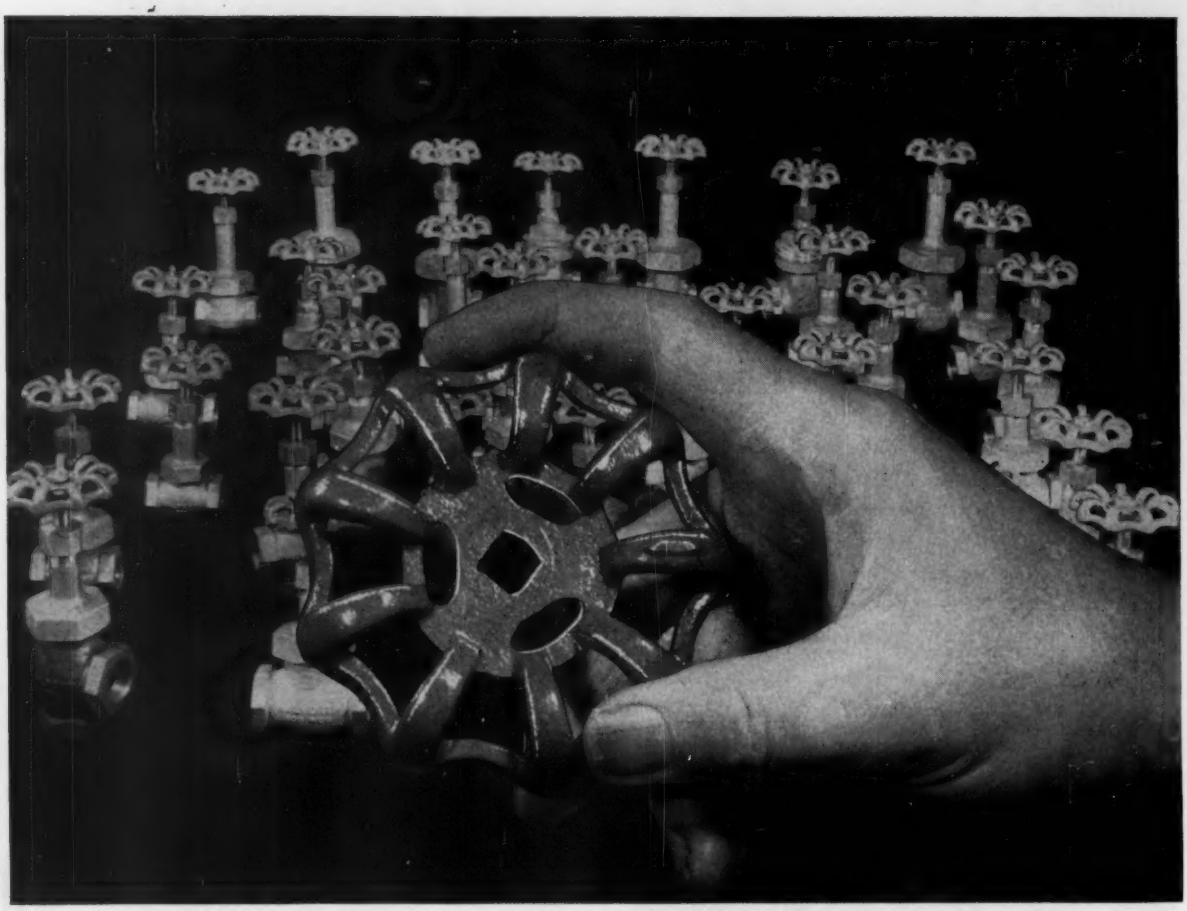
At Morton Salt Company, Manistee, Michigan, the fact that electricity doesn't freeze is vital in this semi-outdoor boiler which handles load swings up to 80,000 lb/hr at 85% efficiency with help of Hays electrically operated combustion control system.



At Falstaff Brewing Corporation, modernization and Hays metering type control have resulted in boiler efficiency of 82%, fuel cost reduction of several hundred dollars per month, CO_2 up from 6% to 12%, and maintenance costs lowered 65%.



At Louisiana Power and Light, a compact Hays B. T. G. control panel only 4 feet wide controls a giant 1,000,000 lb/hr boiler, turbine and generator! Instrumentation and control by Hays includes electronic mercuryless flow meters and other electronic instruments.



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The Walworth system of interchangeability of parts for Bronze Valves is unsurpassed by any manufacturer in the field. In addition to Bronze Valves, Walworth produces valves and pipe fittings of iron, steel, special alloys, and rigid polyvinyl chloride (PVC).

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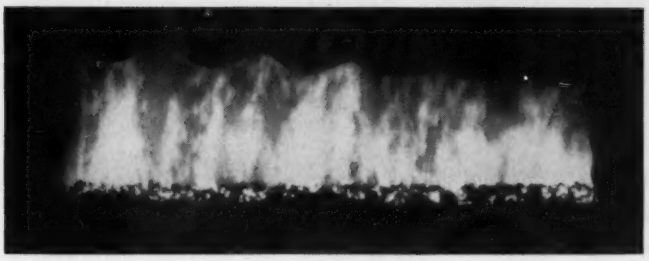
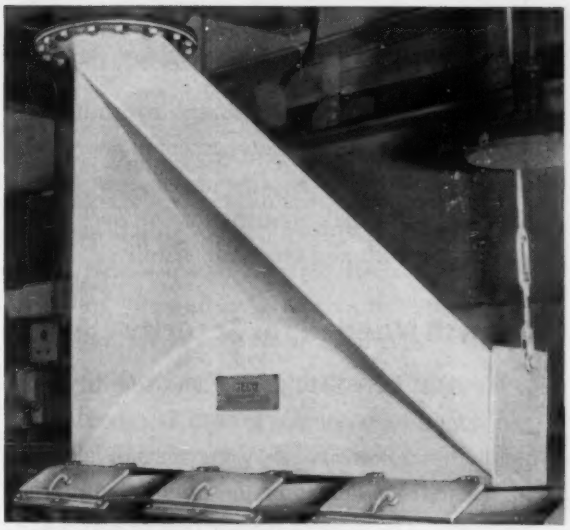
Look at the fire on your stoker



• Coal segregation on your stoker means increased costs due to uneven combustion. Fine coal zones present greater resistance to air flow. Insufficient air means incomplete combustion, unburned fuel in the ash pit. In addition, these zones produce more than the customary amount of smoke.

Coarse coal zones, on the other hand, present less resistance to air flow. More air than required means low CO_2. Also, uncovered stoker iron is exposed to high furnace temperature. Result — expensive repairs and down time.

Take another look at your stoker fire. If you see the tell-tale signs of segregation, you need a S-E-Co. CONICAL Non-Segregating Coal Distributor. This distributor has effectively eliminated coal segregation in hundreds of plants throughout the country. For more information on how you can increase the efficiency and economy of your stoker, write for our Bulletin No. 73. Remember, in scales, valves or distributors, you get more value when you buy S-E-Co.



A graphic description of the principle of the S-E-Co. CONICAL Non-Segregating Distributor (pictured above) is found in our Bulletin No. 73. Write now for your copy.

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Business Investment Holds Key To Both Growth and Stability

What federal tax policy will best promote both growth and stability in the American economy? The Joint Economic Committee of Congress has been asking this crucially important question in public hearings. This editorial suggests one vital part of the answer.

The proposition advanced here is that—

> Tax policy must encourage a continuing high level of business investment in new plant and equipment, because such investment makes a special contribution to *both* economic growth and economic stability.

Growth Needed for Security

We must have both growth and stability.

A vigorous economic growth is essential to our national security. As Congressman Wilbur D. Mills said in launching the Joint Committee's hearings, "The present complexion of world affairs places a premium upon strength and growth in our national economy." Growth is likewise a major ingredient of a healthy domestic economy. Growing enterprises and growing communities offer far more opportunities for satisfying careers than those which are not growing.

A reasonably stable economy, without violent ups and downs, is also essential to our national welfare. Extravagant booms and their more or less inevitable result, severe depressions, waste labor and resources and cause great human misery. Both major political parties have accepted the obligation imposed by the Employment Act of 1946, that the federal government work to maintain high and stable employment.

There is general agreement that **the key to economic growth is investment in new plant and equipment.** Growth depends decisively on new facilities to increase production, and also to produce new and better products in new and better ways. At the same time, new plant investment provides employment for the important, and well-paid, one-fourth of our industrial workers who manufacture and build new production facilities. So if the process of business investment is kept on an even keel, the result is not only growth but also stability in a substantial sector of our economy.

But authorities disagree on the possibility of maintaining a high level of business investment for any great length of time. Some fear that it will lead to an excess of producing capacity and the glutting of markets, with recession or depression not far behind.

The history of our country offers some basis for the fear that it is dangerous to maintain a very high level of business investment. There have been times when the economy has suffered under the weight of excess producing capacity. **This fear, however, has been made obsolete by the recent course of our economic history which, in its earlier phases, nourished the fear.**

The World Has Changed

Here are some of the major considerations, cited at the Joint Committee hearings, which support the conclusion that we not only *can have* a high level of business investment and economic stability but that we actually *need* a high level of such investment to assure stability.

(1) Over the next 20 years our population is expected to increase by about one-third. But most of the population increase will come in age groups younger or older than normal working ages, and people will probably work fewer hours per week. Thus hours worked are not expected to increase more than 15%. Consequently, we must have a relatively large increase in the amount of production equipment per worker if our standard of living is not to suffer. This means a high level of new investment.

(2) About half of our present business investment goes to replace worn-out equipment, rather than to expand capacity as was true during the early stages of our industrial development.

(3) Thanks largely to the impact of organized research—for which we as a nation now spend about $4 billion a year—a large share of capital investment now goes to provide new products and new processes, rather than to expand existing capacity.

These developments make it unlikely that we shall develop the burden of excess capacity that plagued the economy in earlier periods. **Moreover, most capital investment plans are now made on a long-range basis. Companies are building facilities to anticipate their needs for several years ahead.** This increase in long-range planning has reduced the disturbing effects of temporary shortages and excesses in producing capacity.

The record of recent years speaks for itself. Business spending for new plant and equipment in 1955 was over $29 billion. This continued the high level of investment that has been maintained for the past ten years—a decade remarkable for both impressive growth and gratifying stability. A McGraw-Hill survey of preliminary plans for 1956 indicates another year of increasing investment, and expanding business activity.

Tax policy, to be successful, must consider this impressive contribution of business investment to both growth and stability.

Of course, the level of investment depends on many factors other than federal tax policy. The degree of business confidence is important. So is the strength of consumer markets. So is the attitude of organized labor toward the use of more efficient machinery. But tax policy is a crucially important factor. And it is becoming more so with new developments in our changing economy. These developments indicate that tax policy **must be geared to foster a high level of business investment, if the dual objectives of economic growth and economic stability are surely to be attained.**

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Write for Bulletin CT-584

Nothing has more of a bearing on cooling tower performance and life than do tower fan bearings. On them turn *the only moving parts* in an induced draft cooling tower.

Announcement by Halstead & Mitchell engineers of a *permanently* sealed and lubricated fan bearing means a lifetime of continued high cooling tower efficiency. The complete elimination of periodic greasing means a drastic reduction in your tower maintenance costs.

With not one bearing failure reported from hundreds of towers now in use, this advance gives you, more than ever, the best buy in cooling towers on the market today.

HM Halstead & Mitchell
BESSEMER BLDG. PITTSBURGH 22, PA.

New Bearings Available 5 thru 50 tons

20-Year Guarantee!

on the wetted deck surface against rotting or fungus attack is an extra given you only by Halstead & Mitchell. Combined with the H & M *Protected* Steel concept, it offers unsurpassed protection against water and weather.

How much does water affect your Condenser Tube costs?...

...that depends on how resistant your condenser tubes are to the corrosive bite of high water velocity... temperature changes... water composition... contamination... marine organisms.

Bridgeport's Technical Service and Corrosion Laboratory will be glad to help you select the condenser tube alloy best suited to your own operating conditions. Through years of research on the causes of corrosion, Bridgeport has developed a wide range of different alloys — one of which can give you longer service, better operating efficiency and substantially reduced maintenance costs.

For example: Bridgeport Duronze IV Alloy 53 (Arsenical Aluminum Bronze) and Aluminum Brass Alloy 54 offer excellent corrosion resistance to contaminated or corrosive sea waters and a wide variety of fresh waters. They resist impingement corrosion at higher velocities and give longer life under conditions too severe for ordinary condenser tube alloys.

Are you receiving our Copper Alloy Bulletin regularly? We'd like to add your name to our mailing list, to get news of the latest developments in the Condenser Tube field and useful design and maintenance information.

To get more information on the Bridgeport alloy that's best suited for your particular application and for prompt service on your condenser tube requirements, call the nearest Bridgeport Sales Office.

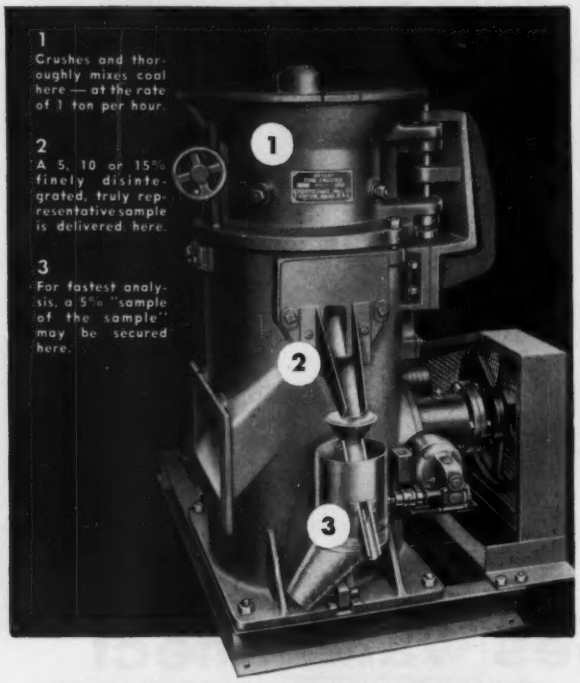
Bridgeport BRASS CO.

BRIDGEPORT BRASS

Offices in Principal Cities • Conveniently Located Warehouses

Bridgeport Brass Company, Bridgeport 2, Connecticut
In Canada: Noranda Copper and Brass Limited, Montreal

Samples Coal Shipments in a Matter of Minutes!


1
Crushes and thoroughly mixes coal here — at the rate of 1 ton per hour.
2
A 5, 10 or 15% finely disintegrated, truly representative sample is delivered here.
3
For fastest analysis, a 5% "sample of the sample" may be secured here.
1
2
3

STURTEVANT COAL SAMPLER

with New Automatic Splitter

It's a fact! Big users of coal and coke know the true B.T.U. value of deliveries before moisture has a chance to evaporate . . . thanks to the speedy crushing, homogenizing and proportioning actions of the Sturtevant Automatic Coal Sampler and its Automatic Splitter. So, they get what they pay for . . . and increase boiler efficiency in the bargain.

Handles a ton an hour! The Sturtevant Automatic Coal Sampler takes 3" or smaller coal or coke and crushes it to 6 mesh or finer. Sample spout takes off 5, 10 or 15% of the finely crushed homogenous mixture, as desired. Then, the optional Automatic Splitter takes a 5% "sample of the sample."

"OPEN-DOOR" DESIGN

provides "One Man, One Minute" accessibility for all cleaning and maintenance — an exclusive Sturtevant feature that saves valuable down-time.

Want more information? *Write for all the facts about the Sturtevant Automatic Coal Sampler — the tested shortcut to accurate B.T.U. analysis.*

STURTEVANT

MILL COMPANY

138 Clayton St., Boston 22, Mass.

CRUSHERS • GRINDERS • MICRON-GRINDERS • SEPARATORS
BLENDERS • GRANULATORS • CONVEYORS • ELEVATORS

Don't wait until the Packing goes!

Your present packing may be good enough, but here's proof that PALMETTO Pyramid will do the job better!

OIL FIELD WATER FLOODING—*Triplex plunger pumps handling abrasive salt water or oil at 4400 psi, 150 F —— PALMETTO Pyramid out-performs all other Vee-type packings in this application.*

FORGING OPERATION—*5000 lb. steamdrop hammer wore out a set of conventional square packing every 2⅓ weeks. PALMETTO Pyramid 2500 lasts 17 weeks under the same operating conditions.*

PLASTIC MOLDER—*Molding press using 130 F oil at 2000 psi, and operating on a 1-minute heat cycle for three shifts each day of a seven-day week, wore out its packing every week to two months. PALMETTO Pyramid 2510 now being used gives better than 1½ years of service life.*

PALMETTO Pyramid packings are designed for rugged service, made of top quality material and molded to meet the demands of the application. If you are having packing problems, our nearest representative will be glad to help you. If you need a Vee-packing that lasts longer, order PALMETTO Pyramid now—from your nearest distributor listed in Thomas' Register.

Write for Bulletin PC-102

packing more performance into every application

PALMETTO Packings

GREENE, TWEED & CO.

NORTH WALES • PENNSYLVANIA

For the Maximum in Fly Ash Recovery...

... an unbiased recommendation from

WESTERN PRECIPITATION

The only organization with 48 years of dust collection experience.

ELECTRICAL, MECHANICAL *and* CMP *types of recovery systems.*

Western Precipitation pioneered commercial application of the now-famous Cottrell **Electrical** Precipitator—has more know-how, more experience, more basic advancements in this highly-technical electrostatic field of recovery than any other organization, domestic or foreign.

Western Precipitation pioneered the multiple small tube type of cyclonic collector—the type with higher centrifugal forces for greater recovery efficiencies. Multiclones are also easier to install, service and maintain—and require less space than other equipment of comparable capacity.

Western Precipitation pioneered the CMP (Combination Multiclone-Precipitator) type of recovery unit now favored by so many leading power plant operators—the unit that combines advantages of both the Mechanical and Electrical principles, and provides almost constant collection efficiency despite varying gas volume.

Plus invaluable know-how

The most important part of **every** Western Precipitation installation is this organization's unequalled experience gained through almost a half-century of continuous leadership in the highly-complex science of recovering suspensions from industrial gases. No other organization—anywhere—offers such seasoned judgment in Electrical, Mechanical and CMP recovery methods. Yet you pay nothing extra for this invaluable "know-how"!

Let us send you literature which describes Western Precipitation's unique services in greater detail. Write, wire or phone our office nearest you!

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors

Western Precipitation Corporation

Designers and Manufacturers of Equipment for Collection of Suspended Materials from Gases and Liquids

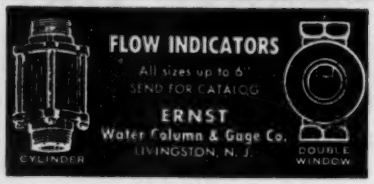
Main Offices: **1049 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA**

Chrysler Bldg., New York 17 • 1 North La Salle Street Bldg., Chicago 2 • Oliver Bldg., Pittsburgh 22 • 3252 Peachtree Rd. N. E., Atlanta 5 • Hobart Bldg., San Francisco 4 • Precipitation Co. of Canada Ltd., Dominion Sq. Bldg., Montreal

WHERE TO BUY

Featuring additional products specialties and services for power plants

STEEL PIPE & TUBING
• CHROME MOLY • CARBON MOLY
• MONEL • CARBON STEEL • STAINLESS
• HASTELLOY
Widest Range of Sizes & Specs in the U.S.
WRITE FOR STOCK LIST
Send us your Surplus Lists
MIDCONTINENT TUBE SERVICE, INC.
2308 Oakton St., Evanston, Ill. DA 8-4030



This WHERE TO BUY section is a special classification for manufacturers desiring advertising in space units smaller than the minimum run of book display space. Space is available in this section in units from one to four inches. Each advertisement is indexed. For low rates write: Classified Advertising Division.
POWER, 330 West 42nd St., New York 36, N. Y.

PROFESSIONAL SERVICES

CONSULTING
CONSTRUCTION
DESIGN
PLANS
EXAMINATIONS
SURVEY • REPORTS
PATENTS
TRADE MARKS

BLACK & VEATCH
Consulting Engineers
Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction,
Investigations, Valuation and Rates
1706 Broadway — Kansas City 12, Missouri

THE LUMMUS COMPANY
Engineers and Constructors
385 Madison Ave., New York, N. Y.
Chicago . . Houston . . London
Paris . . The Hague . . Montreal
Caracas . . Bombay

SEELYE STEVENSON VALUE & KNECHT
Consulting Engineers
Mechanical — Electrical — Civil
Surveys Reports Design
101 Park Avenue — New York 17, N. Y.

BURNS & McDONNELL
Engineers — Architects — Consultants
Kansas City, Mo. — Phone
P. O. Box 7088 — DElmar 3-4375

LUTZ AND MAY COMPANY
Consulting Engineers
Steam, Gas & Diesel Power Station
Pumping Plants—Electric Systems
Reports—Design—Appraisals
1009 Baltimore — Kansas City 6, Mo.

J. E. SIRRINE COMPANY
Engineers
Power Plant — Consultations
Design — Reports
Water — Steam Utilization — Plants
Greenville — South Carolina

GILBERT ASSOCIATES, INC.
Engineers and Consultants
Design and Construction Supervision
Industrial • Sanitary • Chemical Laboratory Services
Business and Economic Research
Industrial Relations • Purchasing
New York — Reading, Pa. — Washington

PIONEER SERVICE & ENGINEERING CO.
Consulting and Design Engineers
Purchasing
Specialists in
Financing, Accounting & Other Operations
231 So. La Salle St. — Chicago 4

STANLEY ENGINEERING COMPANY
Consulting Engineers
327 S. La Salle Street — Hershey Building
Chicago 4, Illinois — Muscatine, Iowa

INTERNATIONAL ENGINEERING COMPANY, INC.
Engineers
Investigations — Reports — Design
Procurement — Field Engineering
Domestic and Foreign
74 New Montgomery St., San Francisco 5, Calif.

FRANK C. REYNOLDS
Registered Consulting Engineer
Surveys, Reports, design and construction supervision of air conditioning, heating, ventilating, oil and gas burners & control systems.
136 Liberty St. — New York 6, N. Y.

A. L. SWANSON AND COMPANY
Consulting Engineers
Power Plants
Sawmills—Industrial Plant Layout
Heating—Ventilating—Plumbing
Reports, Designs, Drawings, Specifications
2210 West 12th Avenue — Vancouver 9, B. C.

THE KULJIAN CORPORATION
Engineers - Constructors - Consultants
POWER PLANT SPECIALISTS
(Steam, Hydro, Diesel)
Utility • Industrial • Chemical
1200 N. Broad St. — Philadelphia 21, Pa.

SANDERSON & PORTER ENGINEERS
Design
Construction
New York — New York

WATER SERVICE LABORATORIES, INC.
Specialists in Water Treatment for Corrosion Prevention
Main Office:
423 W. 126 St. — New York 27, N. Y.

PETER F. LOFTUS CORPORATION
Design and Consulting Engineers
Electrical • Mechanical • Structural
Civil • Thermodynamic • Architectural
First National Bank Building
Pittsburgh 22, Pennsylvania

SARGENT & LUNDY
Engineers
140 South Dearborn St. — Chicago, Illinois

THE J. G. WHITE ENGINEERING CORPORATION
Design-Construction-Reports-Appraisals
80 Broad Street, New York 4

When the Pressure is on—Specify

ALCO

PREFABRICATED PIPE

ALCO has recently added a new, modern prefabricated pipe plant to its manufacturing facilities. As a result, ALCO is better equipped than ever to supply these products to the power, refinery and chemical process industries. To this new facility, ALCO has applied its wealth of engineering experience, production know-how and high standards of inspection and testing. Thus customers are assured of highest quality.

For complete details on ALCO prefabricated piping, call the nearest ALCO Sales Office. Your inquiry will be given prompt attention whether you need piping next week, next month or next year.

ALCO PRODUCTS, INC.

Prefabricated Pipe Products

MOSTELLER ROAD • P. O. BOX 181
CINCINNATI 15, OHIO

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant
Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

DISPLAYED —**RATES**— **UNDISPLAYED**

The advertising rate is $25.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$1.65 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to POWER, 330 W. 42nd St., N. Y. for May issue closing April 6th

FOR OVER 50 YEARS
Leaders in Design, Development & Manufacture of
CUSTOM-BUILT PLANTS & EQUIPMENT

FOSTER WHEELER
CORPORATION

now offers positions—created by a recent expansion—on long-term projects to

ENGINEERS

with a knowledge of, or interest in, ENGINEERING & DESIGNING

STEAM POWER UNITS
CHEMICAL PROCESSING PLANTS
NUCLEAR POWER REACTORS
OIL REFINERIES

FOSTER WHEELER is large enough to provide engineers with career security, its departments small enough to recognize and reward individual accomplishment.

FOSTER WHEELER believes that professional progress is accelerated through self-reliance, so our engineers are assigned diversified projects and are responsible for their development from inception to final specifications. Where needed, assistance is readily available from our excellent staff of specialists; this stimulating contact, we believe, makes a good engineer even better.

FOSTER WHEELER offers professional opportunities which combine breadth of contacts, job variety and faster individual recognition.

If you cannot come in for a personal, confidential interview, send your complete resume to: Mr. G. Tinker . . . or request our illustrated brochure, "Engineering Opportunities."

FOSTER WHEELER
CORPORATION
165 Broadway, New York, N. Y.
WOrth 4-4611

YOUR ORGANIZATION ***Is it complete? Are you expanding it? Making Replacements?***

Naturally, you are anxious to secure the most suitable man or men available. You want men with the special training that will make them an asset to your organization. You can contact such men through an advertisement in the Employment Opportunities Section of POWER.

REPLIES (Box No.): Address to office nearest you
CHICAGO: 520 N. Michigan Ave. (11)
NEW YORK: 330 W. 42 St. (36)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

Wanted detail and design draftsmen with minimum of one year experience in power boiler detail drafting. Please give age, schooling, experience and minimum salary requirements. Springfield Boiler Co., Springfield, Illinois.

SELLING OPPORTUNITY OFFERED

Representatives Wanted. Following territories open: Seattle — Portland — Denver — El Paso — St. Louis — Chicago — Kansas City — Des Moines — Omaha — Okla. City — Little Rock — Birmingham — Baltimore — Wheeling — Pittsburgh — Indianapolis — Louisville. Manufacturer Pressure Reducing Valves, Temperature control valves, diaphragm control valves. Reply RW-1111, Power, 330 W. 42nd Street, New York 36, New York.

POSITIONS WANTED

Power Plant Superintendent, age 34, married, technical education, 11 years experience in the operation and maintenance of steam-electric power plants. Understands personnel problems. PW-9336, Power.

Power or Plant Engineer, technical education. Fifteen years chief engineer, industrial and utility power plants. Ten years plant engineer industrial plants. Complete resume on request. Prefer Northern New England location. PW-1099, Power.

SELLING OPPORTUNITIES WANTED

Sales Engineer desires additional line New York area. SA-8831, Power.

Manufacturer Representatives, engineers, covering largest power and industrial firms in territory, desires equipment lines for Southern Ohio, Southern Indiana, West Virginia, Kentucky and Tennessee. RA-9493, Power.

PERSONNEL MANAGERS

NEED ENGINEERS . . . TECHNICIANS?

Write us today for a free copy of

"RESERVOIR OF ENGINEERS & TECHNICAL MEN"

It explains how you can pin point your employment advertisement to just those men with the job qualifications you want . . . without wasting money on superfluous circulation.

Classified Advertising Division
McGraw-Hill Publishing Company, Inc.
330 West 42nd St., New York 36, N. Y.

POWER PLANT PERSONNEL

A middle east coast utility now constructing a new high pressure, pulverized fuel generating station will accept applications for employment from qualified persons for the following positions, which are available immediately.

Results or Test Engineer

Must be graduate mechanical engineer or equivalent, with experience in modern power plant operation and three years in a responsible supervisory results position. Will be required to assume full charge of power plant testing, chemical control, accounting and research.

Shift Supervisors

To take charge of operation on shift. Must be thoroughly conversant with all phases of modern high pressure, pulverized fuel power plant operation; both electrical and mechanical. Must have previous supervisory experience in power plant operation.

Control Room Operators

Well qualified men needed to operate modern high pressure power plant equipment from an air conditioned central control room. Must be experienced in the actual operation of high pressure pulverized fuel, gas, or oil fired boilers, switchboards, pumps, condensers and associated auxiliary equipment, and be able to direct lower grade operators on shift.

Technician

Graduate Mechanical Engineer. Experience in modern power plant desirable, but not essential. However, applicants must be intelligent and have a real desire to enter modern power plant work. Will assist Results or Test Engineer in the handling of power plant testing, results work and accounting.

Instrument Mechanics 1/C

For men competent in the installation, repair and calibration of all types of industrial instruments, such as flowmeters, remote transmitters, recording pyrometers, pH and conductivity recorders, automatic combustion controls, etc.

Power Pl. Electricians 1/C

Must be qualifed in all phases of modern power plant electrical maintenance. Required to read electrical blueprints and "shoot" trouble on complicated control boards and relay systems.

Job is located near excellent residential community, good working conditions, forty hour week (paid vacations, insurance, sick pay and retirement plan).

High caliber men are needed to fill the foregoing jobs, and for applicants meeting the above requirements, consideration will be given to reimbursement of expenses incurred for the moving of household goods and personal effects.

All personnel selected will receive training at full pay in order to familiarize themselves with the plant before assuming their duties. Include a complete resume of experience and qualifications in first letter. All applications will be treated confidentially.

P-1090, POWER

330 W. 42 St., New York 36, N. Y.

An employment advertisement in this EMPLOYMENT OPPORTUNITIES section will help you find the engineers you need. It's an inexpensive, time saving method of selecting competent personnel for every engineering job in the nuclear field.

du Pont

OFFERS

POWER DESIGN-ENGINEERS

a continuous flow of diversified original assignments

New products with new problems are continually under development at DU PONT—it is our Design Engineers who find successful solutions for the commercial production of these products. Assignments are stimulating, different, difficult—*not* repetitive.

If you are a talented graduate engineer with 4 or more years design experience, DU PONT has opportunity for you. Consider this vital fact—our policy is promotion from within.

APPLY TODAY TO FILL ONE OF THE IMMEDIATE OPENINGS FOR POWER DESIGNER-ENGINEER

Experience in the design of industrial plant facilities required to supply utility services to chemical processes is desired. Applicable experience should be in steam generation and distribution, water supply and treatment, refrigeration, fire protection, outside pipe lines, process waste disposal and industrial furnaces.

Successful applicants will design and engineer a variety of the above mentioned facilities as are required by new or existing chemical processes. Work will involve not only economic installations, but also the challenge of meeting special requirements in connection with process problems.

Please send complete resume to:

MR. T. J. DONOVAN
Engineering Department
E. I. duPont de Nemours & Co., Inc.
Wilmington 98, Delaware

DUPONT
REG. U.S. PAT. OFF.
Better Things for Better Living
...through Chemistry

ELECTRICAL ENGINEERS

Graduate Electrical Engineers for project design, plant maintenance or development groups. Diversified application of electrical engineering including special problems related to the development of instrumentation for process control of plant operations.

Positions available at Junior through Senior levels. Complete program of employee benefits including moving expenses and education refund program.

For prompt and complete information Address Resume of Education and Experience to Employment Supervisor

NATIONAL LEAD COMPANY
CONTRACT OF OHIO OPERATOR
Atomic Energy Commission Project
P.O. BOX 158 MT. HEALTHY STA. CINCINNATI 31, OHIO

INSTRUMENTAL ENGINEER

A large multi-plant manufacturer of Breakfast Foods, located in a pleasant Southern Michigan city, has permanent opening in their Central Engineering Department for a young graduate engineer.

Duties include design of Process Control Systems, application of instruments and controls, supervising installation and preliminary operations, and working with Plant Engineering Department on operating problems.

Proven leadership qualities, and sound work methods are necessary assets.

This position will offer you a starting salary in line with your experience and ability, an opportunity for future growth, above average benefit program including an outstanding Profit Sharing Savings & Retirement Plan, and a fine community for your family.

Send complete resume to:

P9454, POWER

520 N. Michigan Ave., Chicago 11, Ill.

CHIEF POWER ENGINEER

Must be qualified to supervise about 20 men on all problems related to electrical distribution and power plant equipment for a corrugated board paper pulp mill. Location: Midwest. B.S. E E. and/or equivalent in experience. CONFIDENTIAL. NO OBLIGATION. State acceptable starting salary. *A top opportunity.* Send detailed resume to C. R. Logsdon Co., Personnel Consultants to PAPER INDUSTRY, 19 W. Jackson Blvd., Chicago 4, Ill. Refer to position number J-8917.

UTILITIES SUPERVISOR

Affiliate of Standard Oil Company (N.J.) in South America requires man with 10 or more years experience operating power and boiler plants, potable water facilities; preferably in refineries or large chemical plants.

Write giving age, education, marital status and detailed description of experience.

BOX 308-I
Radio City Station
New York 19, N. Y.

A CHALLENGE

How many of these positions are you qualified to fill. Project Manager, Mechanical Engineer, Designer, Draftsman, Squad Leader, Estimator. We are an established engineer-contracting company doing business in four states, plumbing, heating, process piping, boiler house, filter plant, and industrial piping. Not a one job proposition. We need another man who is versatile and can qualify for as many as possible of these positions. Location, Toledo, Ohio. Salary open. Give qualifications and experience.

P-1112, POWER

520 N. Michigan Ave., Chicago 11, Ill.

When Answering
BOX NUMBERS . . .

to expedite the handling of your correspondence and avoid confusion, please do not address a single reply to more than one individual box number. Be sure to address separate replies for each advertisement.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

UNDISPLAYED ——**RATES**—— ***DISPLAYED***

(Not Available for Equipment Advertising)

$1.65 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
Box Numbers count as one line.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.

The advertising rate is $17.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.
An advertising inch is measured ⅞" vertically on one column, 3 columns, 30 inches to a page.

Send new ads to POWER, 330 W. 42 St., New York 36, N. Y. for May issue closing April 10.

GET 2nd ENGINEER PAPERS IN 1 YEAR

(Yes, get better stationary engineers License!)

No correspondence school bother. Nationally-known Chief Stationary Engineer Frederick C. Walker's 100-Question, 100-Answer Bulletins give you the straight dope quick. Send $3 to Walker & Collins, 524 Ashland Ave., Buffalo 22, N. Y. for first set today. Keep working. Save year.

Prepare for
REFRIGERATION LICENSE

More than 300 multiple choice questions from past exams. Many sketches. 96 pages 8½" x 11". Send $3 to:

W. D. TURNER
44 West 63rd St., New York 23, New York

WIRT & TOSH BOILERMAKERS

Thirty years experience
Boiler—Condenser—Stack—Tank—Steel
Erection & Repair Anywhere—Anytime.

Inquires invited

604 Logan Blvd., Burnham, Penna.
Phone: Lewistown 3818
or
2602 Edgmont Ave., Chester, Penna.
Phone: 2-7993

WANTED

Steam Engine Generator Sets • Turbines • Condensers • Generators • Boilers or Complete Power plants.

PAUL OBERMAN
1910 Delmar St. Louis, Mo.

WANTED—A. C. GENERATOR

5,000 Kva, 3 Ph. 60 cycle, 300 or 400 R.P.M. with exciter — 4,160 volt or 13,200 volt 0.8 P.F. must be in perfect condition electrically. Submit outline prints with proposal to:

R. TREVIÑO
San Juan de Letran 21-611 — Mexico City

Locomotives, 15 to 100 tons, diesel, gas.
Locomotive cranes; steel S/L derricks (5).
Clyde Whirley crane, 45-ton, elec., 130' bm.
Colby hammerhead crane, 300', 14-ton.
Link-Belt rotary r.r. car dumper, 115 ton.
Diesel-electric generators, 500 to 3500 KW.
1000 HP diesel gen. set, Nordberg, d.c. 250 v.

H. Y. SMITH CO.
828 N. Broadway Milwaukee 2, Wis.

3 NEW VERTICAL CIRCULATING PUMPS

STEAM TURBINE DRIVEN

Manufactured by Warren Steam Pump Co.—26,500 GPM at 13.5 lbs. and 840 RPM. Test pressure 50 lbs.—submergence 72" water—suction lift 8" Hg. Westinghouse turbine—steam pressure 575 lbs. G.—Superheat O F—exhaust pressure 15 lb. G—HP 300—RPM 4150—Type 20-V-R-G-B—steam chest pressure 900 lbs.—serial No. Pump 23706-23708-23707—Turbines 5A1034-51-50-44.

COCHRANE DEAERATOR

Maximum pressure 20 lbs.—220,000 lbs. per hour—1800 gallons storage volume.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. Curtis 7-5050

DIESEL GENERATOR BARGAINS

LOCATED IN CANADA

4 - 500 KVA 2300-4000/3/60/8 cylinder 360 RPM Diesel Generator sets—with eleven panel switchboard—can be inspected in operation—all in one power House—Good condition.

275 KVA 550/3/60/4 cylinder 260 RPM Worthington-Westinghouse unit with air compressor starting equipment and switchboard. Has been used only slightly as stand by.

2 - 156 KVA 2300/3/60/4 cylinder Vertical Polar Atlas 300 RPM units with direct connected exciters—There are two similar units but some parts missing from one engine. Will sell two for price of one.

100 KW 550/3/60 GE generator driven by General Motors 6 cylinder Diesel with switchboard—There is a second similar engine that has not been used—Take your choice of engines or both.

We also have steam units and other types of equipment.

Please send your enquiries and surplus lists—We have surprised many important customers by producing precious machines for immediate shipment (sometimes new) when many thought it could not be done.

SOUL CLINIC INC.
Calgary, Alberta, Canada

FOR SALE

2—125 KVA Hercules Portable Diesel Engine Generator Sets, 3 phase, 60 cycle, 127/230/460 volts, 1800 RPM, including exciters, switchboards and radiators.
Skid mounted — Excellent condition.

INTERNATIONAL POWER MACHINERY CO.
1610 Union Commerce Bldg., Cleveland 14, Ohio

BAILEY BOILER CONTROL PANEL

For gas and oil, has fluid meter, boiler meter, recorder controller, feed water pres, steam pressure, induced draft, etc. Little use.

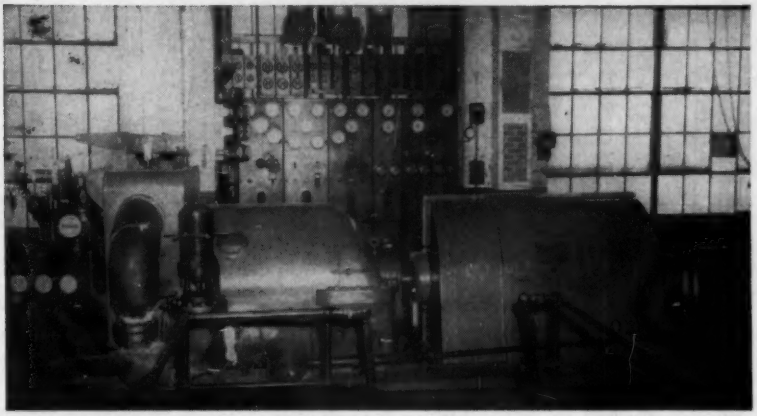
HARRIS MACHINERY COMPANY
501 30th Ave., S. E., Minneapolis 14, Minn.
Fr. 1-1829

2000-KW. at 80% PF., 2500-KVA.

A MODERN WESTINGHOUSE, 400# psig., 750°FTT., 2300-V. CONDENSING TURBINE-GENERATOR

AN EXCEPTIONALLY GOOD MACHINE

Units are Complete with All Operating Auxiliaries.



Other Condensing Turbines in our Stock

ABOVE PHOTOGRAPH SHOWS MACHINE IS OF MODERN DESIGN

Also 2—2000-KW., Westinghouse 400# psig., 750°FTT.; One 1250-KW. Genl. Electric., 400# psig., 750°FTT. All 2300-Volts. Good Condition.

We Carry a Full Line of Diesel Engines, Boilers, Etc. Send us your Specs. of anything Wanted, not Listed.

SEND FOR OUR NEW STOCK LIST.

CHARLES WEAVER
19701 JAMES COUZENS HIGHWAY
DETROIT 35, MICHIGAN

TEL. BROADWAY 3-1901.

COMPRESSOR DIRECTORY
World's Best Rebuilts

15 CFM 1000 psi I.R.	400 CFM 100 psi I.R. XRB
21 CFM 800 psi Curtis	464 CFM 100 psi I.R. ES
48 CFM 3500 psi I.R.	552 CFM 100 psi I.R. XRB
25 CFM 2000 psi I.R.	676 CFM 125 psi I.R. XRB
95 CFM 1500 psi C.P.	377 CFM 125 psi I.R. XRB
124 CFM 40 psi Fuller	1055 CFM 110 psi I.R. XRE
137 CFM 100 psi I.R. ES	2212 CFM 100 psi C.P. OCE
211 CFM 100 psi I.R. ES	PORTABLE 80-600 CFM
230 CFM 1500 psi I.R. ES3	
273 CFM 15 psi Wor-HB	
283 CFM 35 psi I.R. ES	
320 CFM 125 psi I.R. ES	
368 CFM 100 psi I.R. ER	

American
AIR COMPRESSOR CORP
OLLI AVE. & 47th ST.
NORTH BERGEN, N.J.
UNion 5-4848

BLEEDER TYPE TURBO GENERATORS

2—W.H. turbines, throttle press. 340# P.S.I.G., Bleeder Station 110# P.S.I.G. Exh. 30# P.S.I.G. Satu. Steam. Ser. Nos. 12750 & 12751.

W.H. AC gens., 1563 K.V.A., 480 V., 1880 amps, 60 cycle, 3600 R.P.M., type SO-2G135, .8 P.F., 3 ph. Ser. Nos. 4053392—93.

W.H. DC exc., type SK, 16 K.W., 125 volts, 128 amps., 3600 R.P.M., frame 43, sty. No. 2G136.

Still on fndn. In exc. condition. Price and further inf. on request.

PHILADELPHIA TRANSFORMER CO.
Box 566 **Dalton, Pa.**

OPPORTUNITIES!

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New and used equipment recently released from service by a number of electric and gas utility companies

POWER PLANT EQUIPMENT
CONSTRUCTION EQUIPMENT
SUBSTATION EQUIPMENT
TRANSMISSION LINE MATERIALS

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APPARATUS EXCHANGE
Two Rector St., New York 6, N. Y.

SPECIALS

1—5000 KVA TURBO GENERATOR, Condensing, 400 PSI.
1—1500 KW MG SET, 260 volts DC, 2300/4600/3/60.
1—200 KW MG SET, 250 Volts DC, 2300/3/60.
2—300 HP KEWANEE BOILERS, 125 PSI.
2—150 HP UNION WATER TUBE BOILERS, 160 PSI.
1—250 HP B&W BOILER, 150 PSI.
3—4' x 135' STEEL STACKS.
1—70,000 LB. HEINE BOILER, 400 PSI.
1—4133 CFM, I.R. COMPRESSOR, steam driven.
1—1000 CFM, I.R. COMPRESSOR 173 HP Sync. drive.

BRIDGE CRANES

120 ton Cleveland, 70'6" span, 3/60/440.
120 ton Niles, 68' span, 3/60/440.
60 ton Niles, 70'6" span, 230 volts DC (2).
40 ton Niles, 16'5" span, 3/60/440.
40 ton Niles, 70'8" span, 230 volts DC.
20 ton Niles, 63'10" span, 3/60/440.
15 ton Morgan, 75'6" span, 3/60/440 (3).
7½ ton Morgan, 52' span, 3/60/440.
5 ton Niles, 47' span, 230 volts DC.

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DIESEL ENGINES — POWER MACHINERY
100 KW to 1500 KW
Diesel Generator Sets • Stationary • Portable • Mobile Motors and Generators
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GUARANTEED REBUILT POWER EQUIPMENT

SQUIRREL CAGE MOTORS

3 Phase, 60 Cycle, 220 or 440 volts (*2300 volts or higher)

HP	Make	Type	Speed
1250	*Al. Ch.	ANX	3600
1200	*Al. Ch.	ARW	1200
750	*Westg.	CS	900
500	*Al. Ch.	ARW	3600
500	*G.E.	KT5698	900
500	G.E.	KT-424	450
450	*Al. Ch.	ARW	1800
400	G.E.	KT-424	360
300	*G.E.	K-6344Y	1200
300	G.E	K-6353TEFC	720
250	Westg.	CS-TEFC	1800
250	G.E.	KT-559	1800
250	*L.-Allis	OEX-148	720
250	*G.E.	IK	600
250	G.E.	IK-17A	600
250	Westg.	CS-14	514
250	*Cr. Wh.	SC-68	900
200	*G.E.	FT-549Y	3600
200	*G.E.	IK-13B	1800
200	Al. Ch.	ARWWT	585
200	*Westg.	CS	600
200	G.E.	K-6352	514
150	G.E.	IE-13A	1800
150	G.E.	IE-13B	1200
150	*Al. Ch.	AN-30F	1200
150	U.S.	SC-587	1200
150	Westg.	CS-7728	1200
150	*Westg.	CS-8120STEC	1200
150	Westg.	CS-876C TEFC	900
150	*Westg.	CS	600
125	Westg.	CS-771 Spdf	1800
125	*Al. Ch.	AR	1800
125	Al. Ch.	AR-226 CS	1800
125	*Reliance	AA 6065	900
100	Westg.	CS6078 TEFC	3600

D.C. MOTORS

(*230 Volt)

HP	Make	Type	Speed
250	Westg.	SK-220	450/600
200	Westg.	SK-201	650
200	Cr. Wh.	CM	500
175	G.E.	ELC	750
100	G.E.	MPC	400/800
100	G.E.	RC-34	2500
100	G.E.	RC-19	575
100/150	G.E.	MCF	380/1000
50/120	G.E.	MCF	250/1000
50	Cr. Wh.	CMC	700/1100
50	G.E.	DLC-204	650
35	Westg.	SK-150	350/1000
30	Cr. Wh.	CCM-504	450
30/40	G.E.	CD-115	500/1500
25	G.E.	RC-32	800
25	Westg.	SK-133	575
20/25	Westg.	SK-151L	250/1000
20	Star	SB-10	1750

M.G. SETS

KW	Make	A.C.	D.C.
1250	Westg.	6600/4160	600
1000	G.E.	12,000	600
500	Westg.	2300	275
300	Westg.	2300/440	250
400	A.C.	2300	120/240
200	G.E.	2300	230/275
200	Westg.	2300/4000	230/275
200	Ridgeway	2300	250
170	G.E.	440	125
150	G.E.	2300	125/250
150	A.G.	2300	275
150	Westg.	2300	125/250
150	G.E.	440	275
100	G.E.	2300	250
100	Elec. Mash.	440	125
100	G.E.	440	125
90	G.E.	440	60

SLIP RING MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2300 Volts or Higher)

HP	Make	Type	Speed
2000	*G.E.	MT	600
1250	*Al.-Ch.	ANY	1800
1250	*Westg.	CW	600
1000	*Westg.	CW	250
700	*Al-Ch.	ANY	1200
600	*G.E.	MT	450
500	Westg.	CW	350
500	Westg.	CW	900
400	Al-Ch.	3 brg.	450
300	*G.E.	IE-15A	1800
250	*G.E.	I-N	450
250	Westg.	HF-15H	600
200	G.E.	IK-15B	900
200	G.E.	IM	600
150	Cr. Wh.	50-R	1800
150	G.E.	MT-540	1800
150	*Wagner	RS-131	900
150	Westg.	CW	450
125	G.E.	IM-15A	600
100	G.E.	IM-13A	1800
100	G.E.	IM	600
100	G.E.	IM-15A	450
75	G.E.	MT-347	1200
75	G.E.	IM	1200
75	Al. Ch.	ARY-223C	1200
75	G.E.	MT-356	900
75	Al. Ch.	ANY-26F	900
75	Al. Ch.	ARY	720
75	G.E.	IM	600
60	*Westg.	CW-762C	900
50	*Al. Ch.	ARY-220-BS	1800
50	Westg.	CW	1800
50	*Al. Ch.	ARY	1200
50	Westg.	CW-636A	1200
50	Westg.	CW-658A	900
50	G.E.	MT-336	900

SLIP RING MOTORS

Crane & Hoist Service
3 Phase, 60 Cycle, 220 or 440 Volts

HP	Make	Type	Speed
80	G.E.	MTC-5552	600
75	Westg.	CI-756A	600
50	Westg.	MW-334	600
50	G.E.	HICTENV	600
35	G.E.	MTC-5536	600
20	Westg.	CI	1200
11	Westg.	CI-E464	900
10	P & H	BW-6	1800
5	P & H	BW-6	1200
5	N. West.	WRC	1200
3	G.E.	MTC-5044	900

PUNCH PRESS MOTORS

NEW—3/60/220-440 Volt
High Torque—Hi-Slip

HP	Make	Type	Speed
75	Fr.-Morse	QFZK	1065
60	Westg.	CS-752-C	1060
40	Reliance	AA-B-505	1635
30	L-Allis	OK-445	1060
25	Reliance	AA-C-504	1100
15	Imperial	F-444	1090

TURBINE GENERATORS
3750-2500-1563 KVA
Westinghouse & General Electric
400 lb. PSIG - 750 FTT, 3 Phase, 60 Cycle, 220 Volt. All with 2 pass surface condensers, exciter and control. Prints and detail available. 3750 KVA Westg. new in 1948

CHICAGO *Electric Co.* 1320 WEST CERMAK RD, CHICAGO 8, ILL.

3 G. M. 200 KW DIESEL GENERATOR SETS

Reconditioned by U.S. Navy

EQUAL TO NEW

Complete with motor driven starting air compressors, air tanks, dead front type generator switch panels and all other necessary accessories.

ENGINES

G.M. Model 8-268A—6½x7—1200 RPM—air starting—complete with engine operating panels, heat exchangers, cooling pumps, filters, strainers, governors, pyrometers, etc.

GENERATORS

Westinghouse 200 KW 250 KVA—440/3/60—1200 RPM—80% P.F.—continuous—drip-proof enclosure—direct connected exciter.

SIZE AND WEIGHT

Each unit, mounted on a pre-fab sub-base, is 13' 9 5/16" long, 3' 10½" wide, approx. 8' high. Weight of engine and generator only 17,705 lbs. Each unit, with all accessories, about 27,000 lbs.

CONDITION

No expense has been spared to put these 3 units in "equal to new" condition. Don't miss this opportunity to buy! Inspection can be made at our warehouse, Curtis Bay, Baltimore.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. CURTIS 7-5050

NEW 25 CYCLE — MOTORS AT LONG DISCOUNTS

Qu.	HP	Make	Phase	Volts	Brg.	Frame	RPM
16	¼	Wag.	1	110/220	Sl.	65X	1425
9	⅓	Wag.	1	110/220	Sl.	65X	1425
10	½	Whse.	3	220/440	Sl.	145	1425
8	¾	Whse.	3	220/440	Sl.	186	1425
3	¾	Whse.	3	550	BB	186	1425
3	¾	G.E.	3	220	Sl.	77	1425
3	1	L.A.splash	3	550	BB	224	1450
5	1	Whse.	3	220/440	Sl.	FX224	1450
7	2	L.A.splash	3	550	BB	FX225	1450
5	3	L.A.splash	3	550	BB	FX254	1450
1	5	L.A.splash	3	550	BB	FX284	1450
3	10	L.A. XP	3	220/440		JEX364	1450
1	15	G.E. used	3	220/440		365	1450
1	25	Rel. XP	3	220/440		405	1450

TRANSFORMERS

80—1⅛ KVA, Line Material, Dry tpe, 120/240/480 volt primary to 120/240 volt secondary with taps, 1 phase, 60 cycle
3—250 KVA, General Electric, OISC, 2300 volt primary, 460/230/115 volt secondary, 1 phase, 60 cycle
6—500 KVA, Westinghouse, OISC, 2300 volt primary, 460/230 volt secondary, 1 phase, 60 cycle.

BENSON-WILIMZIG, INC.
1704 N. 8th St., St. Louis 6, Mo.
Phone GArfield 1-4290

30 HP Self-contained Hi-Pressure Boiler.
50 & 40 HP Package Type Boilers — EXCELLENT.
150 HP, 150 lbs. Pressure Self-contained.
78"x20' HRTs; tested but never used.
42" & 48" Belt Conveying Equip. complete.
4x8' Vib. w/Stainless Steel Screens.
Several Large Claridge Roller Brg. Fans.
Several 200 HP Magnetic Red. Vol. Starters.
H. & P., 6719 Etzel, St. Louis 14, Mo.

DIESEL GENERATOR SETS

3—1500 HP General Motors Model 16-576, 720 RPM, 1000 KW Elliott 3/60/2400 V generator. Like new.

1—720 HP Fairbanks Morse Model 33, 5 cyl. 257 RPM, 580 KVA F-M 3/60/2400 V generator.

1—560 HP Fairbanks Morse Model 33, 4 cyl. 257 RPM, 470 KVA F-M 3/60/2400 V generator.

MISSISSIPPI VALLEY EQUIPMENT CO.
507 Locust St. St. Louis 1, Mo.

FOR SALE
18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.
Will sell turbines separately if desired. *Price reasonable.*
Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
408 DONOVAN BLDG.
DETROIT 1, MICH.

—TRANSFORMERS—
BOUGHT AND SOLD

We carry a large stock of rebuilt and guaranteed transformers, and invite your inquiries.
Custom-built transformers and coils manufactured to your specifications.
Expert Repair Service—all makes and sizes of transformers rewound, repaired and redesigned. Ask for our price schedule.

THE ELECTRIC SERVICE CO., INC.
5318 Hetzel St. Cincinnati 27, Ohio
40 Years' Dependable Service

LIDGERWOOD HOIST

Serial #8001. 250 H.P. 2300 volt slip ring motor drive Hoist designed for 350 f.p.m. of 1⅞" rope. Face of drum 55-9/16", diameter to bottom of groves, 84" Electric brake connected. Split drum, all steel base, Blue prints available.

2000 KVA G.E. type H. T. Form D.H. 66,000/22000/2300/60 cycle. Serial #4540898.

ELJAY INC.
L. J. LAND, Pres.
401 Broadway, New York 13, N.Y.
Telephone WOrth 6-0969

SPECIAL: A 10,000-KW. @ 80% P.F., Or 12,500-KVA., Complete

GENERAL ELECTRIC TURBINE-GENERATOR SET: GOOD

FOR 400# (WITH CHANGES): WAS OPERATED AT 250#, 600° F.

12,500-KVA., General Electric Turbine-Generator is a Special Offering. Is complete with all accessories, including a C. H. Wheeler, 2-pass Surface Condenser with all auxiliaries, a complete Switchboard and an 85-KW., Direct Connected Exciter. Generator voltage is 3/60/13,800-Volts. Machine is our own property. Can make Immediate Delivery. Drawings and any further information desired will be furnished on request.

WE INVITE CORRESPONDENCE

Send Us Your Specs. for Anything Wanted in POWER EQPT.

CHARLES WEAVER

19701 James Couzens Highway
Detroit 35, Michigan

TELEPHONE BROADWAY 3-1901

BOILER FEED PUMPS

STEAM TURBINE DRIVEN

GPM	TFH	Stage	Mfg.
450	892	4	Worth. (2)
500	850	4	Worth.
200	1375	6	Ingersoll R. (2)
200	850	2	Weinman (2)
190	1320	4	De Laval
750	725	4	Worth. (2)

MOTOR DRIVEN

GPM	TFH	Stage	Mfg.
740	2250	5	Worth.
700	1550	8	Worth.
675	1100	5	LeCourtenay
500	1050	5	Worth. (3)
100	1150	5	Gould

UNDERWRITERS FIRE PUMP

GPM	TFH	Stage	Mfg.
1500	231	1 (motor driven)	Fairbanks
750	231	(gas. driven)	Allis Chal. (2)

MOTOR DRIVEN SAND PUMPS

American Manganese 10"
Allen-Shaffer-Hoff 14"

NASH HYTOR COMPRESSORS

(4) size #2, 850 R.P.M., 10# pressure, 240 C.F.M.; 860 R.P.M., 180 C.F.M., when used as a Vacuum Pump.

2—2800 Gal. cap. 100# steam press. hot water storage heaters, mfg. by Quaker City Iron Works. Good shape.

This is only a partial listing of pumps carried in stock. We have hundreds of other pumps, compressors, and power equipment. Don't ask us what we have, write and tell us what you want.

PHILADELPHIA TRANSFORMER CO.
Box 566 Dalton, Pa.

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
800	2300	Whse.	900
500	2200	G.E.	450
450	440	Whse.	514
400	4000/2300	Whse.	450
400(2)	2300	G.E.	900
300	2200/440	G.E.	720
300	440	G.E. (hoist)	600
300	440	Whse.	3600
250	2200/440	G.E.	1200
250	440/220	Whse.	600
250	550/440	G.E.	1200
225	4000/2300	G.E. (hoist)	600
200	440/220	Whse.	514
150(2)	440/220	G.E.	720
150	2200/440	G.E.	600
125	550/440	G.E.	1200
125	2200	G.E.	600

SYNCHRONOUS MOTORS 3-Ph 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G.E.	ATI	720
375	2200	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G.E.	TS	720
300	2200/440	G.E.	TS	1200
250	2200/440	G.E.	TS	720
250	440/220	Whse.	HR	277
250	440/220	G.E.	ATI	600
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2200	G.E.	FT	3600
500	2200/4000	Elliot	SC	1800
400	2300/4000	Whse.	CS	720
400	2300/4000	G.E.	K	1800
350	440	G.E	KT	1200
300	2300/4000	L. Allis	FS	1800
250	2300	Whse.	CS	600
250	2300	G.E.	K	900
225(2)	2200/440	G.E.	KT	1200
200	440/220	G.E.	KT	1800
200	2200/440	G.E.	JK	600
200	2200	G.E.	KT	1800
150	2300	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440/220	G.E.	KT	720
130	2300/440		KT	600

A. C. GENERATORS

1—320 kva, 600 rpm 2300/440/220 V., G.E.
1—300 kva, 900 rpm, 3200 V., Whse.
1—225 kva 60 rpm, 220/440 V., G.E.
1—200 kva, 720 rpm 2300/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKR-155-28, 600 amp., 15,000 V. G.E.
1—400 Amp., Condit, 3P. 25 KV outdoor
1—400 Amp., R. Smith, 3P. 7.5 KV outdoor

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	2870
150	230	El. Dyn.	B/brg.	600
150	230	Whse.	SK	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2200	Syn.	250
240	G.E.	4000/2300	Syn.	250
175	G.E.	220/440	Syn.	230
150	Whse.	440/220	Sq. ca.	275
125	G.E.	4000/440	Syn.	125
125	G.E.	440/220	Syn.	250/125
100	Al. Ch.	220/440	Sq. Ca.	240/120
65	G.E.	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—1000 kva, Whse., 13,800—2300 V., 3 ph., New
1—600 kva, Standard, 13,800—2300 V., 3 ph.
2—333 kva, G.E., 23000/11500—2300 V.
3—333 kva, Mol. 13,800—2300 V.
2—333 kva, G.E., 2400—480 V.
2—300 kva, G.E., 4150—240 V., 3 ph., Pyr.
2—200 kva, Mol., 13,800—2300 V.
3—200 kva, G.E., 2300—575 V.
3—100 kva, Al. Ch., 2400—480/240 V.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

FOR SALE

545 KVA Fairbanks Morse diesel engine generator unit, 6 cylinders, model 33D14, 3 phase, 60 cycle, 2400 volts, 300 RPM, including direct connected exciter and engine auxiliaries.

Excellent condition—Can be shown in operation.

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1610 Union Commerce Bldg., Cleveland 14, Ohio

"SERVICE IS OUR TRADEMARK"

Rewinding and Reconditioning— All Types Transformers

FOR SALE: Phase Changers And Dry Type Transformers For Special Applications

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ATLANTIC TRANSFORMER CO. MI 4-6963

Rebuilt HEMPHILL Guaranteed EQUIPMENT

TRANSFORMERS 60 CYCLE

Qu	KVA	Make	Type	PH.	Voltages
2	750	G.E.	H	1	4600x120/240
1	400	Pitts.	OISC	1	4150x240/480
2	333	West.	S	1	4150-240/480
2	300	G.E.	H	1	13200-110/220
3	200	G.E.	H KD	1	13800/12420/4600-240/480
3	50	G.E.	H	1	2400/4800-120/240
1	25	G.E.	Pyranol	1	2400/4160-120/240
3	200	G.E.	H	1	7800/15600-440/220

SYNCHRONOUS MOTORS

QU	HP	Make	Speed	Type	Volts
1	1400	G.E.	514	ATI	4150
1	1000	West.	360	Mill	2300/4150
1	500	Whse.	450	HR	2300
1	300	EM	720	TEFC	2300
1	300	G.E.	600	ATI	220/440/2400
1	200	Whse.	600	ATI	240
1	150	G.E.	1800	TS	220
2	150	Allis	360		2200
1	125	G.E.	600	TS	2200
1	125	EM	900		4800
1	100	G.E.	900	TS	2200

SLIP RING MOTORS

QU	HP	Make	Speed	Type	Volts
1	500	G.E.	1200	M	2400/4150
1	400	Whse.	450	CW	450
1	250	Whse.	600	CW	440
1	200	Whse.	600	CW	440
3	150	A.C.	1800	AY RW	2300
1	100	G.E.	1800	IM	220
1	75	G.E.	600	IM	440
1	60	G.E.	1800	MT	220
1	200	Whse.	514	CW	440

SQUIRREL CAGE 60 CYCLE

Qu.	HP	Make	Type	Speed	Volts
1	200	West.	C.S. Exp Proof	1800	220/440
2	250	G.E.	K.F. TEFC	1800	2300
1	150	G.E.	KT-562	690	440
1	100	West.	CS	1200	440

MOTOR GENERATOR SETS

QU	KW	Make	Speed	DC	AC
1	1000	G.E.	514	600	2300/4150 syn
1	1000	Whse.	720	600	2300/4150 syn
1	1000	Whse.	720	275	2300/4150 syn
1	300	G.E.	1200	250	2300/4150 SR
1	150	C.W.	600	125	220/440
1	100	Cr. Wh.	1200	250	Elect Mach. 550V Syn.
1	97	G.E.	1200	60	4150 Syn
1	75	G.E.	1800	250	220/440 SC
1	60	Whse.	1200	60	2200V
3	60	EM	1200	125	220
1	30	Whse.SK	1750	250	2300/4150 Syn
1	20	EM	1800	125	220 V
2	30	G.E.	1800	125	220/440 V

DC, 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
2	150	C.W.	900	WP
1	125	G.E.	1700	RC
2	75	C.W.	900	WP
3	30	C.W.	700	CM
1	35	G.E.	860	RC
1	25	Whse.	835	SK
1	30	G.E.	1650/1800	CDM85

FOR POWER
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LOCOMOTIVE BARGAIN

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214 HP at 1200 RPM	407 HP at 900 RPM
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1500 KW West. Non-C. extr. 3/60/2400 V 3600 RPM 450 PSIG 75# extr. 12# BP

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D.C. MOTORS WITH M.G. SETS & CONTROLS

Qu.		MAKE	TYPE	VOLTS	R.P.M.
1—2200	HP	G.E.	MCF-12	600	400/500
2200	KW	G.E.	Syn.	2300/4600	514
1—1250	HP	Whse.	Rev.	600	300/600
1000	KW	G.E.	Syn.	2300/4600	720
1—1250	HP	G.E.	MCF	600	750/900
1000	KW	G.E.	Syn.	2300/4600	720
1—1000	HP	G.E.	MCF-8	600	350/700
1000	KW	G.E.	Syn.	2300/4160	720
1— 200	HP	G.E.	CD-1650Z	250	500/1500
200	KW	Whse.	Syn.	440	1200

ALSO MANY OTHER COMBINATIONS

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G.E.	MT	6900	1187
1	1100	G.E.	IM	2300	720
1	1000	A.C.	Mill	2300	240
1	800	G.E.	MT	2300	293
1	750	G.E.	MT-573	2200	1190
1	700	Al. Ch.	D.P.	2300	500
1	500	Whse.	CW	550	350
1	400	Whse.	CW-960A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2200	435
1	350	G.E.	IM-17A	440/2200	720
1	250	G.E.	MT-559S	2300	1800
1	250	G.E.	MT-424Y	4000	257
1	250	A.C.		550	600
1	200	G.E.	IM	2200	580
1	150	Whse.	CW30E17	2300	435

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
2	650	G.E.	FT-559BY	440	3570
2	450	Whse.	CS-1420	2300/4150	354
1	400	G.E.	1E-15B	2300	1165
1	400	G.E.	1K	2200	500
1	200	G.E.	IK-17	440	580
2	200	G.E.	KT-557	440	1800
1	150	Whse.	CS	440	580

SYNCHRONOUS

1	4350	C.W.	2501-SL	13800/6900	514
2	1750	G.E.	ATI	2300	3600
2	2000	Whse.		2300	120
1	735	G.E.	ATI	2200/12000	600
1	500	Ideal	SM	2300/4160	1800
2	500	G.E.	TS-7567	2200	1200
1	450	Whse.		2200	450
1	400	G.E.	TS	2200	400

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
1	2500(3U)	Whse.	720	600	2300
1	2000	G.E.	500 25cg	660	11000
2	2000	G.E.	514	600	6600/13200
1	1750/2100	G.E.	514	250/300	4800/2400
1	1500	G.E.	720	600	6600/13200
1	1500	G.E.	514	250	2300/4600
1	1250	Whse.	720	600	2300
1	1000	G.E.	900	250	6600
1	750	Whse.	900	250	2300/4150
1	750	G.E.	900	125/250	2200
1	500	Whse.	900	125/250	440
1	300	Whse.	1200	250	440/2300
1	200	Whse.	1200	250	220/440
1	150	Whse.	1200	600	2300
1	150	Whse.	1200	275	2300

WELDING M.G. SET

Gen. Elec.—1100 Kva—0.7 p.f.—2300/4600 V. 3/60 Generator with 1750 Kva—.8 p.f.—2300 V. 3/60 motor complete with exciter set and controls.

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	2500	A.C.	OA	3	6900/11900x2400/4160Y
3	333	G.E.	HS	1	7200x2400x4160Y
3	333	G.E.	RSWR	1	2300/4000x230/460
3	333	G.E.	HD	1	18200x2530x4350Y
3	250	Penn.	OISC	1	34500x120/240
3	200	Whse.	OISC	1	13200x120/240

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	13200/13200
1	5000	G.E.	60/50/60	6600/11000/6600
2	2500	G.E.	25/62.5	2300/2300
1	1000	G.E.	25/58.3	4400/2300
1	500	Al. Ch.	25/60	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G.E.	Condensing 425 — 750 F.T.T. Surface Condenser 3/60/2300/4000 V Direct con exciter.
1	1500	Whse.	Auto extraction 190 lbs. — 660° F.T.T. 60 lb. extraction 3/60/240 V. Div. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200# U.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300. Non-condensing 175/200 lbs. I.S.P. 5/20 lbs. G.B.P., 430/3/60.

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43 Howell St., Jersey City 6, N. J.

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1003	Whse. syn cond		4000/2300	900
485	Allis Ch.	1 brg.	480	400
312	Gen. Elec.	ATI	240/480	900
275	G.E. 25 cycle	ATI	480	750
225	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
150	El. Machy		240/480	900
156	Whse.	C	240/480	1200
150	Whse.		2300/480	600

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A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
700	Allis Ch.	Sq. Cage	440	900
600	G.E.	Slipring	2300	600
600	G.E.	Synch.	2200	327
500	G.E.	Sq. Cage	2200	3600
500	G.E.	Sq. Cage	4000	1800
450	Allis Ch.	Synch.	480	400
400	Whse.	Sq. Cage	2200	514
400	G.E.	Synch.	440	450
300	Whse.	Synch.	440	1200
300	Gen. Elec.	Slipring	220/440	1200
300	Al. Ch.	Sq. Cage	2200/440	720
300	G.E.	Slipring	440	360
250	Gen. Elec.	Sq. Cage	440	3600
250	Whse. X-P	Sq. Cage	2200	3600
250	G.E.	Slipring	220/440	720
250	G.E.	Sq. Cage	220/440	900
250	Gen. Elec.	Synch.	220/440	450
250	G.E.	Synch.	220/440	720
250	L.A. (2)	Sq. Cage	2200	1200
225	G.E.	Synch.	220/440	900
200	Reliance b.b.	Sq. Cage	220/440	1200
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	220/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2200/440	900
200	E.M.	Synch.	220/440	1200
175	G.E. (2)	Synch.	220/440	720
150	El. Machy.	Synch.	220/440	360
150	Allis Ch. (2)	Slipring	220/440	1200
150	G.E.	Slipring	2200/440	720
150	G.E. (4)	Slipring	2200/440	600
150	G.E. (2)	Sq. Cage	2200/440	720
150	Allis Ch.	Sq. Cage	440	450
125	Gen. Elec.	Slipring	440	600
125	G.E.	Slipring	220/440	720
125	G.E. TEFC	Sq. Cage	220/440	3600
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G.E.	Slipring	220/440	450
125	G.E. b.b.	Sq. Cage	2200/440	1200
100	Ideal	Sq. Cage	2200	1800
100	G.E.	Slipring	220/440	720
100	G.E.	Slipring	220/440	514

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D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
200	Reliance	1400-T	230	850
150	Whse.	SK-201	230	300/900
150	Whse.	SK-184	230	850
100	Reliance	851F	550	1000/1600
100	Reliance	851-T	230	575/1150
75	Whse.	SK-180	230	475/900
75	Cr. Wh. TEFC	55H	230	850
75	F. Morse b.b.	DH-140	115	1800
50	G.E. (3)	CD-125	230	400/1200
40	Reliance b.b.	131-T	550	1750
35	Gen. Elec.	RP-14	230	250/1000
30	Imperial b.b.	D69	230	400/1800

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V.
300	Gen. Elec.	2200/440 AC	260 DC
200	El. Machy.*	2200/440 AC	250 DC
200	Whse.*	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Whse.*	220/440 AC	250 D
175	Gen. Elec.	220/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	G.E.*	2200/440 AC	125 D
100	Whse.	220/440 AC	250 D
75	Cr. Wheeler	25 cycle	125 DC
75	Cr. Wh. b.b.	220/440 AC	250 DC
75	Whse.	2200/440 AC	600 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Whse.	220/440 AC	250 DC
30	Gen. Elec. (2)	220/440 AC	125 DC
30	Allis Ch.	220/440 AC	250 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	G.E. (2)	CY-275	250	1200
200	Reliance	1400T	250	1200
150	Whse. b.b.	SK-163L	250	1800
150	Whse.	SK-184	250	1150
105	Century b.b.	1500 amp.	70	1200
100	Allis Ch.	E	125	1200
100	Reliance	851T	600	1200
75	Cr. Wh. b.b. (2)	CCD	250	1150
75	Whse. b.b.	SK-163	125	1000
75	Whse.	SK	250	600
50	Gen. Elec.	CD-115	250	1150

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5000 KVA Westinghouse Condensing Turbine, 400 PSI, 3600 RPM 3/60/2400/4150 Generator, 6300 sq. ft. surface Condenser, 1000 HP Heine Water Tube Boiler 400 PSI, complete with water walls, superheater, pulverizers and all accessories,—on foundations.

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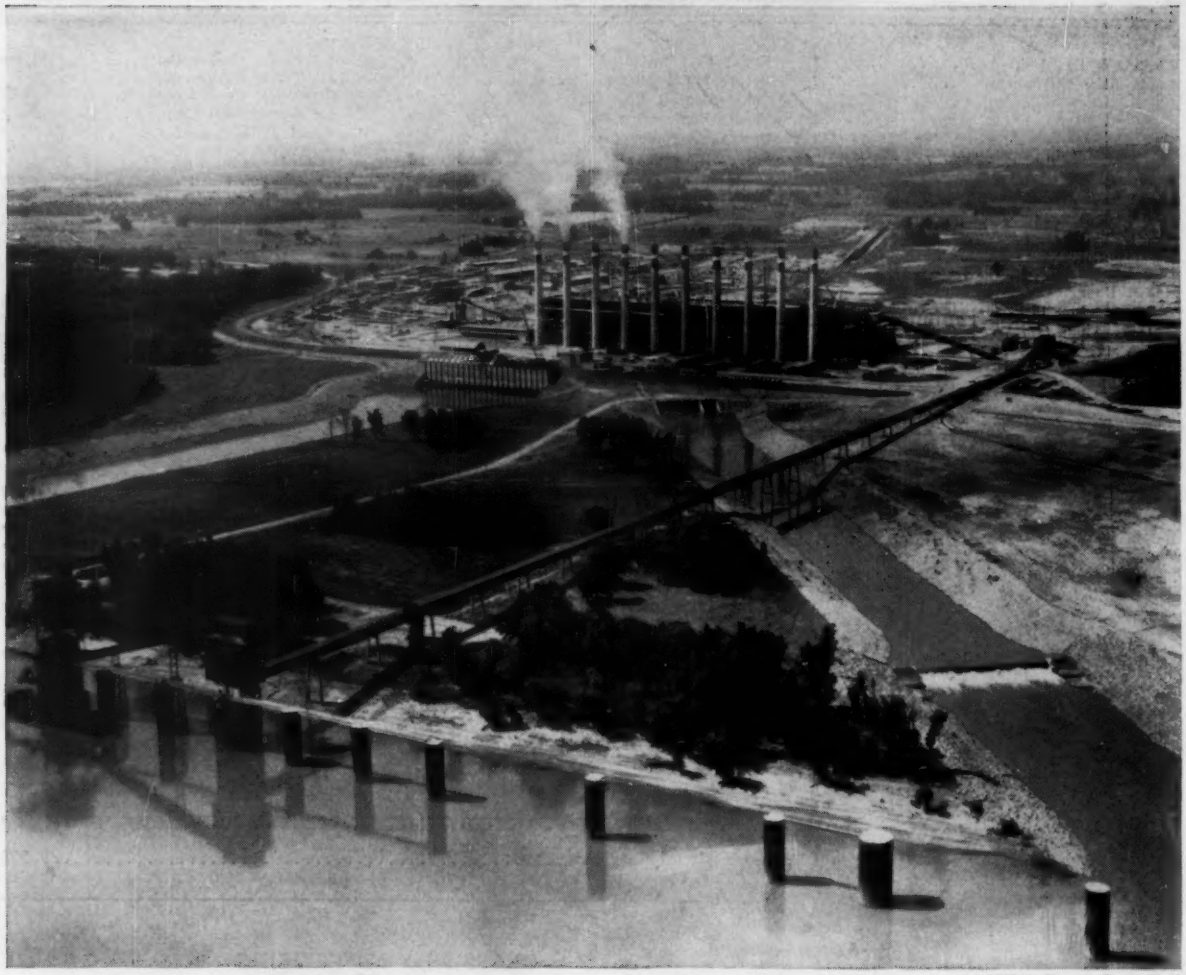

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